

# World revision of *Ortheziola* Šulc (Homoptera: Coccoidea: Ortheziidae) with descriptions of eleven new species

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**Abstract.** Soil samples and museum collections were analysed from all zoogeographic regions of the world. From this material eleven new species of *Ortheziola* Šulc are described from Africa and the U.K., five additional species are redescribed and a key is presented for the identification of all sixteen species. A slightly modified concept of the genus is presented and several new characters are given as diagnostic of the genus. A phylogenetic hypothesis is given based on analysis of the morphological features of adult females. Results show that *Ortheziola* is most diverse in eastern Africa where relatively more advanced species occur. Basal species occur primarily in western Africa and Asia.

## Introduction

Ortheziidae is considered to be one of the oldest families of Coccoidea (Koteja, 1985; Foldi, 1997). Research on the classification and distribution of the family may provide further insight into the origin and phylogeny of Coccoidea. According to Williams & Watson (1990), the family, which includes about eighty species in six genera, may have originated in Africa and/or South America. The most detailed analyses of Ortheziidae were presented by Morrison (1925, 1952), and covered the entire world fauna.

A large series of soil samples was collected over a period of many years by Dr S. Mahunka and colleagues, Hungarian Natural History Museum, Budapest. He used collecting methods such as Berlese funnels, soil traps and sifting screens and obtained samples from all zoogeographic regions of the world (Mahunka & Mahunka-Papp, 1992). The Mahunka surveys were undertaken to obtain mites, but many scale insects also were collected, and the first author was given the opportunity to examine the samples for their scale insect contents. Emphasis in this study is on the African samples, since they have a diverse array of undescribed species in *Ortheziola* Šulc and *Newsteadia* Green. We have also studied specimens from alcohol-preserved soil samples from several other museums including The Natural History Museum in London. A total of 856 soil samples was examined from eighteen African

countries (Algeria, Burkina Faso, Central African Republic, Angola, Congo, Egypt, Ethiopia, Ghana, Guinea, Libya, Madagascar, Malawi, Nigera, South Africa, Tanzania, Tunisia, Zaire). Within Ortheziidae, these samples included 225 adult females and 276 immatures. More than half of the specimens represent species in *Ortheziola*, including ten previously undescribed species. A large number of samples were also examined from the Transvaal Museum in Pretoria. These included 555 samples all from South Africa; fourteen samples contained specimens of *Ortheziola* and included sixty specimens.

The purpose of this paper is to provide a comprehensive revision of *Ortheziola* including descriptions of eleven new species, redescriptions of five previously described species and to provide a hypothesis of relationship of the included species.

*Ortheziola* is poorly understood. The best known species is *Ortheziola vej dovskiy* Šulc; which occurs in the western-European montano-boreal area and is occasionally taken in quarantine outside of Europe in mosses used as packing material. Morrison (1954) described a second species from Africa (*O. guineensis* Morrison). He pointed out the similarity of this disjunct distribution pattern with species of *Newsteadia* and *Nipponorthezia* Kuwana and suggested that additional *Ortheziola* species would be discovered in Europe and Africa. Mamet (1955, 1959) described two additional species from Madagascar (*O. madecassa* Mamet and *O. ankazobeensis* Mamet), giving support to the hypothesis of Morrison. Richard (1990) described a fifth species from Nepal (*O. loebli* Richard).

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## Materials and methods

Most insects described in this study were collected using soil and litter sampling devices and are from the Collection of Arachnida of the Hungarian Natural History Museum, Budapest, Hungary. The insects studied were prepared on microscope slides or are preserved in alcohol and are deposited in the following collections: The Natural History Museum, London (BMNH); Hungarian Natural History Museum, Budapest (HNHM); Muséum National d'Histoire Naturelle, Paris (MNHN); Plant Protection Institute, Hungarian Academy of Sciences, Budapest (PPI); National Museum of Natural History, Washington, D.C. (USNM). All holotypes of new species are deposited in PPI except the new species from the U.K., which is deposited in BMNH. Measurements and numbers are from ten specimens when available, and are given as a range followed by the average in parentheses.

## Terminology

Terminology follows that of Morrison (1925, 1952). Some new terms include: 'wax plates', which are the clusters of spines and pores that are distributed on the integument (Fig. 1); 'thumb-like pores', which are pores that are conical in appearance and form a cluster on each side of the anal ring (Fig. 1), and 'modified pores', which are the small pores that are scattered over the derm and are usually associated with the spines and setae (Fig. 1). In order to study the homology of the wax plates, a system identifying the various wax plate areas on the integument was established. This system utilizes a series of numbers that identify homologous wax plates (each adult female illustration has the wax plates numbered). The terms 'band' and 'row' are used in very specific ways. A 'row' of spines consists of a series of spines arranged side by side that are no more than one spine thick. A 'band' of spines consists of a series of spines arranged side by side that are at least two spines thick, usually more.

The terminology, structure and evolution of the quadrilocular pores merit special mention in relation to *Ortheziola* species. In *Orthezia urticae* (Linnaeus), quadrilocular pores are scattered over most of the body and are the predominant pore type. They are relatively flat in side view, all approximately the same size and easily determined as quadrilocular pores in nearly any view. In *Nipponorthezia guadalcanalia* Morrison the quadrilocular pores are modified; the actual quadrilocular structure appears to be invaginated into the derm in a shallow tube. In side view the structure appears like a shallow tubular duct, but they are easily determined to have four loculi. There are two integrating sizes of these ducts. In *Mixorthezia reynei* (Laing) the pores are predominantly trilocular, occur in a tube and there is only one size of pore. The locular structure is not readily apparent unless viewed directly into the dermal opening. In species of *Ortheziola*, the quadrilocular pores have become so modified that they are difficult to recognize as a homologous structure. There are two distinct sizes. The larger size is usually associated with

the rows of spines contained within the ovisac bands, can be fairly easily discerned as a quadrilocular or trilocular pore if the pore is viewed from directly above, is at the end of a tubular invagination in the derm and has a tube projecting beyond the dermal surface (Fig. 11). The smaller size can only be determined to have loculi under an oil immersion objective, and only when the view into the pore is perfectly lighted and orientated. The smaller pores have a long tube and look very much like small tubular ducts in other families of scale insects and do not have a projection from the dermal surface. A scanning electron microscope micrograph shows these two sizes of modified pores (by courtesy of S. Takagi).

## Phylogenetic analysis

In order to develop an hypothesis of relationship of the species of *Ortheziola*, a preliminary analysis of Ortheziidae was undertaken to discover the sister group of *Ortheziola*. The analysis included twenty-eight characters and an exemplar of each of the following ortheziid genera: *Arctorthezia* Cockerell (exemplar *A. pseudoccidentalis* Morrison); *Mixorthezia* (exemplar *M. reynei*); *Newsteadia* (exemplar *N. americana* Morrison); *Nipponorthezia* (exemplar *N. guadalcanalia*); *Orthezia* Bosc (exemplar *O. urticae*); *Transnewsteadia* Richard (exemplar *T. nepalensis* Richard). *Icerya purchasi* Maskell (Margarodidae) was used as the outgroup. We decided not to include details of the analysis because they are preliminary, but the results clearly demonstrate that *Nipponorthezia* is the sister group of *Ortheziola*, with *Mixorthezia* being the next basal taxon. This relationship remained the same if any or all of the generic exemplars were excluded from the analysis or were used as the sole or combined outgroups. Although *Mixorthezia* shares two unique and apparently complicated characters with *Ortheziola*, it seems clear that *Nipponorthezia* is the sister group of *Ortheziola*. The characters are the presence of a false basal antennal segment that is fused or partially fused with the eye and the presence of a sclerotized plate on the dorsomedial area anterior of the anal ring. The latter structure is not as well developed in *M. reynei*, but it appears to be similar to the well developed sclerotized plate in *Ortheziola* species. Although our final analysis included only the sister group *Nipponorthezia guadalcanalia*, inclusion of multiple outgroups had interesting ramifications.

We examined only two specimens of *Ortheziola loebli* and relied heavily on the detailed information presented in the original description (Richard, 1990). Appendix 1 lists all relevant characters for *Orthezia urticae* (outgroup), *Mixorthezia reynei*, *Nipponorthezia guadalcanalia* and the sixteen species of *Ortheziola*. Appendix 2 comprises the character matrix. Outgroup comparison was used to determine the polarity of characters and all multistate characters were treated as unordered. Phylogenetic analyses were performed with PAUP 3.1.1 (Swofford, 1993) using the heuristic search protocol with 500 random-addition se-

quence replicates and the cladogram bisection reconstruction branch swapping algorithm. The selected successive-weighting protocol was weights of 0–1000. The DELTRAN optimization criterion was selected for determining the character state of equivocal branches (Maddison & Maddison, 1992). A simple decay analysis was undertaken by running a general heuristic search and keeping cladograms with one, two or three steps more than the shortest cladograms and examining the clades that remain in the strict consensus cladogram (Bremer, 1994). We also present similar data using the majority rule consensus cladogram. MACCLADE 3.01 (Maddison & Maddison, 1992) was used to study character distribution.

### *Ortheziola* Šulc, 1895

Type species. *Ortheziola vej dovskiyi* Šulc, 1895, by monotypy.

Adult female in life with series of marginal, mediolateral and medial waxy protrusions corresponding to wax plates on slide-mounted specimens. Distribution of these protrusions varies among species. Body segmentation is not visible except in *O. vej dovskiyi* and presumably *O. britannica* Kozár & Miller.

Slide-mounted specimens with antennae 3-segmented; third segment with slender apical seta, flagellate sensory seta, small subapical seta; second segment with one sensory pore. Eye stalks protruding, thumb-like, fused with sclerotized area at base of antenna, sometimes called pseudobasal antennal segment (Morrison, 1925). Legs well developed; leg setae robust, spinelike; trochanter and femur fused, tibia and tarsus fused; tibia with one sensory pore and at least one flagellate sensory seta; tarsus without digitule; claw digitules hairlike, claw without denticle. Labium 2-segmented, basal segment apparent; with many setae, with 3 long setae near apex of labium in single setal socket and very close together (illustrated by Koteja, 1974). Anal ring present in fold of derm on dorsal surface, with 6 setae. Sclerotized plate on dorsum anterior of anal ring, wider than long. Modified pores with 2–4 loculi, scattered over surface, appearing similar to microtubular ducts. Thumb-like pores in cluster laterad of anal ring. Abdominal spiracles ventral on anterior segments, with at least one present on each side of abdominal segments 1–3; when present, posterior abdominal spiracles located on dorsum near anal ring surrounded by cluster of multilocular pores.

**Diagnosis.** Antennae 3-segmented; eye on basal pseudo-segment of antenna; claw with hairlike digitules; well developed sclerotized plate present anterior of anal ring; triad of setae on each side of apex of labium; some wax plates coalesced, not arranged segmentally; with pores with more than 4 loculi somewhere on body.

**Comments.** *Ortheziola* are similar to *Mixorthezia* and *Nipponorthezia* by having four or fewer antennal segments. *Ortheziola* differ from *Mixorthezia* by having the wax plates coalesced and not placed segmentally, the tibia and tarsus fused, two or fewer spine bands inside the ovisac band, thumb-like pores near the anal ring, triad of setae on each side of the

labium and hair-like claw digitules. *Mixorthezia* have the wax plates placed segmentally, the tibia and tarsus separate, more than two spine bands inside the ovisac band, no thumb-like pores, no triplex setae on the labium and spine-like claw digitules. *Ortheziola* differ from *Nipponorthezia* by having three-segmented antennae, the claw digitules hairlike, a dorsal plate and a triad of setae on each side of the labium. *Nipponorthezia* have four-segmented antennae, the claw digitules spinelike, no dorsal plate and no triad of setae on the labium.

The condition of the abdominal spiracles bears special mention. In most specimens these structures are difficult to see even using an oil immersion objective. There is a maximum of four pairs of abdominal spiracles. On the venter these structures may be present on segment 1 at approximately the same distance from the body margin as the posterior thoracic spiracle, on segment 2 just anterior of the ovisac band and on segment 3 inside the ovisac band near the anterolateral angle. A fourth pair is present on the dorsum laterad of the anal ring in the middle of a cluster of multilocular pores. It is not clear if there are species-specific differences in the number of abdominal spiracles because it is not always possible to determine if they are truly absent or are obscured because of the quality of the preparation.

### Key to adult females of *Ortheziola*

1. Wax plates 17 and 18 present anterior of hind coxae (Fig. 2) ..... 2
- Wax plates 17 and 18 absent from area anterior of coxae (Fig. 1) ..... 8
- 2(1). Dorsomedial area bare, without wax plates (Fig. 1) ..... 3
- Dorsomedial area with wax plates (see plates 8, 9 and 10), not bare (Fig. 9) ..... 6
- 3(2). Less than 30 multilocular pores laterad of each thoracic spiracle; tibia-tarsus less than 750 µm long ..... 4
- More than 35 multilocular pores laterad of each thoracic spiracle; tibia-tarsus more than 750 µm long ..... *jerestii* Kozár & Miller
- 4(3). Length of hind tibia-tarsus more than 450 µm long; length of labium more than 140 µm long; length of apical antennal segment more than 300 µm ..... 5
- Length of hind tibia-tarsus less than 450 µm long; length of labium less than 140 µm long; length of apical antennal segment less than 300 µm ..... *williamsi* Kozár & Miller
- 5(4). Setae on antennae hairlike; anal ring with 3 rows of pores ..... *mahunkai* Kozár & Miller
- Setae on antennae spinelike; anal ring with 2 rows of pores ..... *benedictyae* Kozár & Miller
- 6(2). Setae on antennae spinelike; multilocular pores present in complete row anterior of each spine band within ovisac ..... 7

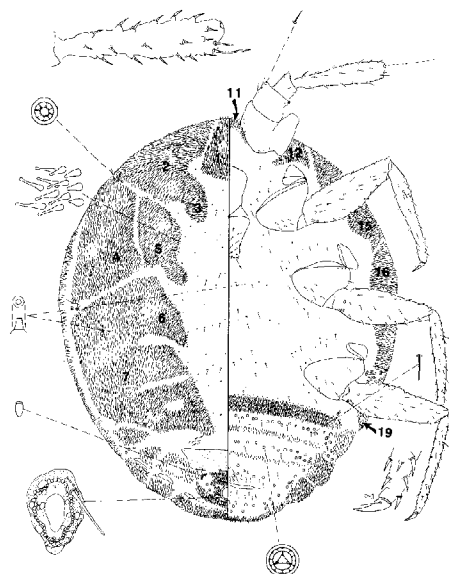
- Setae near apex of third antennal segment hairlike; multilocular pores absent anterior of spine band within ovisac..... *loebli* Richard
- 7(6). Wax plates 13, 17 and 18 surrounding entire coxa; hind tibia-tarsus more than 740 µm long.....  
..... *kosztarabi* Kozár & Miller
- Wax plates 13, 17 and 18 limited to area anterior of coxae; hind tibia-tarsus less than 700 µm long.....  
..... *guineensis* Morrison
- 8(1). Wax plates limited to area surrounding thoracic spiracles on ventral thorax (wax plates 15 and 16 present, 19 absent or represented only by small cluster) (Fig. 3) ..... 9
- Wax plates scattered along entire margin of ventral thorax (wax plates 15, 16 and 19 present and conspicuous) (Fig. 1) ..... 13
- 9(8). Wax plate 11 present between antennae; wax plate 12 present laterad of antennae; anal ring with 3 rows of pores (Fig. 11) ..... 10
- Wax plates 11 and 12 absent; anal ring with 2 rows of pores (Fig. 4) ..... 12
- 10(9). With 2 spine bands inside ovisac band; with sclerotized plate posterior of anal ring ..... *madecassa* Mamet
- With one spine band inside ovisac band; without sclerotized plate posterior of anal ring ..... 11
- 11(10). Wax plate 3 divided into 2 lateral pieces; plate 19 represented by small cluster of spines laterad of hind legs ..... *britannica* Kozár & Miller
- Wax plate 3 undivided medially; plate 19 absent .....  
..... *O. vejidovskyi* Šulc
- 12(9). Multilocular pores laterad of thoracic spiracles in tight cluster, with 7–14 pores in each cluster; incomplete rows of multilocular pores associated with spine bands in ovisac band ..... *ethiopienensis* Kozár & Miller
- Multilocular pores laterad of thoracic spiracles scattered, with 1–3 pores in each cluster; complete rows of multilocular pores associated with spine bands in ovisac band ..... *matileferreroae* Kozár & Miller
- 13(8). Wax plates 6 and 7 separate ..... 14
- Wax plates 6 and 7 combined .....  
..... *ankazobeensis* Mamet
- 14(13). Hind tibia-tarsus less than 800 µm long; setae at apex of trochanter-femur and on third antennal segment spinelike, with acute apices ..... 15
- Hind tibia-tarsus more than 800 µm long; setae at apex of trochanter-femur and on third antennal segment hairlike with capitate apices.....  
..... *nelliae* Kozár & Miller
- 15(14). Dorsomedial clear area wider than length of labium; third antennal segment with 40 or fewer setae; with 0–3 multilocular pores associated with each thoracic spiracle; spiracular multiloculars with 5–6 loculi.....  
..... *jernyi* Kozár & Miller
- Dorsomedial clear area about same width as length of labium; third antennal segment with more than 40 setae; with 6–12(8) multilocular pores associated with each thoracic spiracle; spiracular multiloculars with 8–9 loculi ..... *giliomeei* Kozár & Miller

***Ortheziola ankazobeensis* Mamet, 1959 (Fig. 1)**

*Ortheziola ankazobeensis* Mamet, 1959: 391.

**Type material.** Adult female holotype mounted alone on slide; left label: 'MADAGASCAR/Ankazobé/forêt Ambohitantly/VII.1955/R. Paulian coll./no. 594/MNHN 8720/1'. Right label: 'TYPE/Ortheziola/ankazobeensis/Mamet/TYPE/on?/MNHN – 8720/1'. Adult female paratype, MADAGASCAR: La Mandraka, on an undetermined host, vs. 1953 (R. Paulian). Deposited in the MNHN (we examined the holotype only). **Other material.** SOUTH AFRICA: one adult female, Kitsoek forest Station, 1100 m, 12.xii.1986 (S. Endrödy-Younga) (no. 4827 from the collection of S. Endrödy-Younga); 4 adult females, Weze, Bangeni Forest, *Podocarpus* sp., 21.xi.1989 (S. Endrödy-Younga) (no. 4884 from the collection of S. Endrödy-Younga); 4 adult females, Transvaal, Berlin Forest Station, xx.ix.1985 (S. Endrödy-Younga) (no. 4828 from the collection of S. Endrödy-Younga); one adult female, Northington Forest, 1420 m, 13.xii.1989 (S. Endrödy-Younga) (no. 4883 from the collection of S. Endrödy-Younga); one adult female, Karkloof National Reserve, 13.xii.1989 (S. Endrödy-Younga) (no. 4829 from the collection of S. Endrödy-Younga). Deposited in the PPI, MNHN, USNM and BMNH.

**Unmounted adult female.** Unknown. **Mounted adult female** (Fig. 1). 1.08 mm long; 0.87 mm wide. Size of antennal segments: 1st 77 µm long, 77 µm wide; 2nd 57 µm long, 43 µm wide; 3rd 222 µm long, 49 µm wide; 3rd segment slightly



**Fig. 1.** *Ortheziola ankazobeensis* Mamet.

clubbed shaped; apical seta of antenna 149  $\mu\text{m}$  long (taken from original description, broken on holotype); subapical seta 47  $\mu\text{m}$  long; flagellate sensory seta near apical seta 23  $\mu\text{m}$  long; microseta absent; without unusual hair-like setae near subapical seta; all segments of antennae covered with small number of hair-like, curved setae, with acute apices; longest seta 17  $\mu\text{m}$  long; first antennal segment with one hair-like sensory seta on each side of segment; third antennal segment with 23 setae not counting apical setae. *Venter*. Labium 106  $\mu\text{m}$  long. Stylet loop longer than labium. Legs with front coxa 111  $\mu\text{m}$  long, middle 116  $\mu\text{m}$ , hind 128  $\mu\text{m}$ ; front trochanter-femur 270  $\mu\text{m}$  long, middle 285  $\mu\text{m}$ , hind 298  $\mu\text{m}$ ; front tibia-tarsus 275  $\mu\text{m}$  long, middle 280  $\mu\text{m}$ , hind 326  $\mu\text{m}$ ; front claw 35  $\mu\text{m}$  long, middle 40  $\mu\text{m}$ , hind broken; front digitule 10  $\mu\text{m}$  long, middle broken, hind 12  $\mu\text{m}$ ; legs with rows of robust setae; longest on trochanter-femur 20  $\mu\text{m}$  long; with one flagellate sensory seta on each tibia, 15  $\mu\text{m}$  long; trochanter with 4 sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal plate laterad of each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of coxae (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with 2 bands of spines within ovisac band. Thoracic spiracles with multilocular pores associated with each spiracular opening, each group containing (1–3) pores, 7  $\mu\text{m}$  in diameter (several of these pores on dorsum); diameter of anterior thoracic spiracles 22  $\mu\text{m}$ . Setae few, scattered in medial areas of thorax, with setae near anterior edge of ovisac band (none capitate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores surrounding vulva. Multilocular pores with 12 or 13 loculi around perimeter, 3 or 4 loculi in central hub; present in one complete double rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present, with 2 pairs on each side of body anterior of ovisac band and one pair inside ovisac band near anterolateral angle; with sclerotized vestibule. *Dorsum*. Wax plates cover two-thirds of marginal area of surface; mediolateral thoracic plates small (plates 3, 5 and 6), leaving conspicuous bare areas on mediolateral thoracic region; broad medial and submedial area of thorax and abdomen without spines and pores; plates 2 and 3 combined; plates 6 and 7 combined. Spines at margin of wax plate 4 12  $\mu\text{m}$  long, in middle of wax plates 17  $\mu\text{m}$  long; spines capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 setae laterad of thoracic spiracles, longest seta 19  $\mu\text{m}$ ; also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 12 loculi around perimeter, 3 loculi in central hub present in cluster near anal ring, in submarginal areas of posterior abdominal segments and opposite thoracic spiracles. Sclerotized plate 67  $\mu\text{m}$  long, 206  $\mu\text{m}$  wide; with 2 setae near posterior edge of plate. Anal ring with incomplete double row of round pores (2–3  $\mu\text{m}$  in diameter); longest seta 22  $\mu\text{m}$  long (tip of seta is broken); shorter than length of anal ring; ring 37  $\mu\text{m}$  wide, 47  $\mu\text{m}$  long. Thumb-like pores 4  $\mu\text{m}$  long. Modified pores 4  $\mu\text{m}$  long. Abdominal spiracles present in multilocular cluster near anal ring, without sclerotized vestibule.

*Comments.* *Ortheziola ankazobeensis* differs from all other species in the genus by having dorsal wax plates 2 and 3 combined and plates 6 and 7 combined.

***Ortheziola benedictyae* Kozár & Miller, sp.n. (Fig. 2)**

*Type material.* *Holotype*, female, COMORO ISL.: Anjouan, Dindri, secondary rainforest, elevation 901–1000 m, 6–8.viii.1992 (T. Pócs, R. E. Magill & A. Rupf) (no. 9272) (no. 783 from the collection of S. Mahunka). *Paratypes*, 3 females, COMORO ISL.: Anjouan, Dindri, secondary rainforest, elevation 901–1000 m, 6–8.viii.1992 (T. Pócs, R. E. Magill & A. Rupf) (no. 9272) (no. 783 from the collection of S. Mahunka); one female, COMORO ISL.: Anjouan, Nikingi, mossy elfin forest, elevation 1200–1593 m, 7.viii.1992 (T. Pócs, R. E. Magill & A. Rupf) (no. 9274) (no. 781 from the collection of S. Mahunka); 5 females, COMORO ISL.: Anjouan, Moya, submontane rainforest, elevation 640 m, 12.viii.1992 (T. Pócs, R. E. Magill & A. Rupf) (no. 9279) (no. 786 from the collection of S. Mahunka). *Other material* (not paratypes). One female, TANZANIA: Uluguru, Lupanga, from litter, elevation 2050 m, 18.iii.1972 (T. Pócs) (no. 129 from the collection of S. Mahunka); one female, TANZANIA: Uluguru-Kifigo, from litter, elevation 1750 m, 25.v.1972

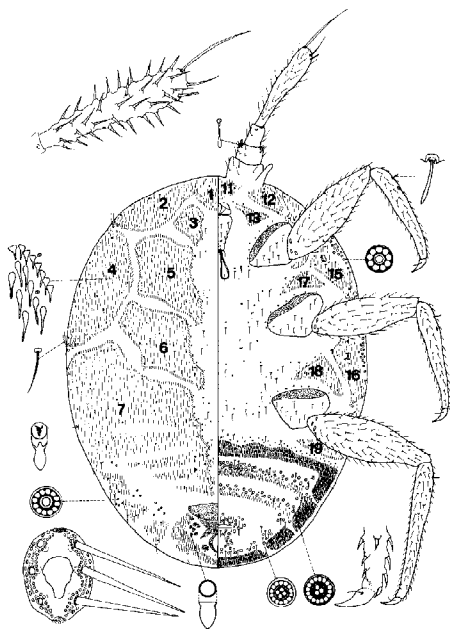


Fig. 2. *Ortheziola benedictyae* sp.n.

(T. Pócs) (no. 136 from the collection of S. Mahunka); one female, TANZANIA: Ukoguru-Mnyera peak, from epiphyte moss, elevation 2110 m, 1.i.1973 (T. Pócs) (no. 181 from the collection of S. Mahunka); one female, TANZANIA: from litter 1989 (S. Mahunka & T. Pócs) (no. 749 from the collection of S. Mahunka); 6 females, TANZANIA: from litter 1989 (S. Mahunka & T. Pócs) (no. 753 from the collection of S. Mahunka). Deposited in the PPI, HNHM, USNM and BMNH.

*Unmounted adult female.* Most of dorsum covered with white, wax protrusions; narrow band on midline of the dorsum bare. *Mounted adult female* (Fig. 2). Holotype adult female 1.58 mm long (paratypes 1.56–1.74(1.70) mm); 1.16 mm wide (paratypes 1.16–1.33(1.21) mm). Sizes of antennal segments: 1st 84 µm long (paratypes 128–140(135) µm), 84 µm wide (paratypes 94–126(110) µm); 2nd 70 µm long (paratypes 74–86(80) µm), 60 µm wide (paratypes 57–67(61) µm); 3rd 415 µm long (paratypes 368–398(384) µm), 64 µm wide (paratypes 62–89(75) µm), 3rd segment slightly club-shaped; apical seta of antenna 157 µm long (paratypes 131–198(169) µm), subapical seta 64 µm long (paratypes 67–82(73) µm); flagellate sensory seta near apical seta 25 µm long (paratypes 28–38(32) µm); microseta present near apex of antenna, unusual hair-like seta absent from near subapical seta all segments of antennae covered with many very robust, straight, apically acute setae, longest seta 32 µm long (paratypes 35–47(38) µm, first antennal segment with 2 clavate sensory setae on each side of segment (paratypes with 1–3(2) setae), third antennal segment with 65 setae excluding apical ones (paratypes 63–74(70) setae). *Venter.* Labium 180 µm long (paratypes 183–210(192) µm). Stylet loop usually shorter than labium, rarely slightly longer. Legs with front coxa 160 µm long (paratypes 168–185(176) µm), middle 163 µm (paratypes 158–197(180) µm), hind 182 µm (paratypes 185–222(206) µm); front trochanter-femur 398 µm long (paratypes 434–484(463) µm), middle 432 µm (paratypes 471–502(482) µm), hind 506 µm (paratypes 508–558(532) µm); front tibia-tarsus 432 µm long (paratypes 428–465(450) µm), middle 465 µm (paratypes 477–502(472) µm), hind 647 µm (paratypes 570–620(594) µm); front claw 62 µm long (paratypes 58–64(62) µm), middle 60 µm (paratypes 57–65(62) µm), hind 60 µm (paratypes 59–72(65) µm); front claw digitules 16 µm long (paratypes 15–22(18) µm), middle 16 µm (paratypes 18–25(21) µm), hind 26 µm (paratypes 19–28(24) µm); legs with rows of robust setae, longest leg seta of trochanter-femur 31 µm long (paratypes 30–42(38) µm); with one flagellate sensory seta on each tibia, 34 µm long (paratypes 30–52(42) µm); trochanter with 3 sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal plate laterad of each thoracic spiracle (plates 15 and 16); with triangular-shaped bands in front of each coxa (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band, with 2 rows of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 9–20, predominantly 9 locular pores, 6 µm in diameter (paratypes 6–7(6) µm); diameter of anterior thoracic spiracles 31 µm (paratypes 32–42(35) µm). Setae few, scattered in medial

areas of thorax, with several setae near anterior edge of ovisac band and associated with multilocular pores. Multilocular pores with 14–16 loculi around perimeter, 3 or 4 loculi in central hub; about 10 µm in diameter; present in 2 complete double rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; with sclerotized vestibule. *Dorsum.* Wax plates cover most of surface; mediolateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; narrow medial area of thorax and abdomen without wax plates. Spines at margin of wax plate 4 14 µm long (paratypes 16–17(16) µm), in middle of wax plates about 20 µm long, spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates, with 3–6 setae laterad of thoracic spiracles, longest seta 26 µm long (paratypes 25–35(32) µm) also present in very small numbers on other wax plates and in medial bare area. Multilocular pores primarily with 12 loculi around perimeter, one loculus in central hub, paratypes usually with 9 locular pores; 6 or 7 µm in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 67 µm long (paratypes 64–77(73) µm), 218 µm wide (paratypes 220–247(234) µm), with 2 apically acute setae on posterior edge of plate. Anal ring with incomplete double row of round pores (2 µm in diameter); anal ring seta broken (paratypes 49–67(60) µm) longer than length of anal ring; ring 48 µm wide (paratypes 47–64(56) µm), 58 µm long (paratypes 40–67(52) µm). Thumb-like pores 4 µm long (paratypes 6–7(6) µm). Modified pores 4 µm long (paratypes 6–7(6) µm). Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola benedictiae* is similar to *O. fercsii* and *O. williamsi* by having a narrow bare area in the dorsomedial area of the thorax and abdomen and by having triangular-shaped wax plates anterior of the hind two pairs of legs (plates 17 and 18). *Ortheziola benedictiae* differs from *O. fercsii* by having the spiracular clusters of multilocular pores scattered along the body margin, with 9–20 pores near each thoracic spiracle, the apical antennal segment about 380 µm long, tibia-tarsus length of the hind leg about 590 µm long. *Ortheziola fercsii* has the spiracular multilocular pores concentrated into tight clusters, with 42–64 pores near each thoracic spiracle; the apical antennal segment about 560 µm long, the tibia-tarsus length of the hind leg about 830 µm long. *Ortheziola benedictiae* differs from *O. williamsi* by having a triangular-shaped wax plate anterior of the front coxa (plate 13), 9–20 pores near each thoracic spiracle, antennal segment 3 about 380 µm long and the tibia-tarsus about 590 µm long. *Ortheziola williamsi* has the triangular-shaped wax plate anterior of the front coxa absent (plate 13), 2–7 pores near each thoracic spiracle, antennal segment 3 about 240 µm long and the hind tibia-tarsus about 380 µm long.

Several specimens are not included as paratypes because they possess a smaller number of multilocular pores and have different sizes of setae on the antennae and legs. This species is named in honour of Konczné Benedykt Zsuzsanna (Hungary), acknowledging her help in the scale insect studies of the first author.

***Ortheziola britannica* Kozár & Miller, sp.n. (Fig. 3)**

**Type material.** One adult female holotype labelled as follows: left label '*Ortheziola/britannica*/Kozár & Miller/HOLOTYPIC'; right label '*Ortheziola/vejvodskyi*, Šulc./from crevices in/bark of log./Haddington/Scotland./coll. W. Evans. Nov. 1905/(BMNH)'. Twelve adult female paratypes on 6 slides as follows: 'ENGLAND, Isle of Wight, on moss on cliffs, vii. 1905 (R. Newstead) (BMNH and PPI); 2 females on one slide, from England in quarantine at Seattle, in moss packing, 6.ii.1951 (G. M. Hess) (USNM).

**Unmounted adult female.** Probably identical with *Ortheziola vejvodskyi*, except the wax tuft produced by wax plate 3 would be absent. **Mounted adult female** (Fig. 3). Holotype 1.59 mm long (paratypes 1.59–1.86(1.79) mm); 1.21 mm wide (paratypes 1.36–1.56(1.40) mm). Size of antennal segments: 1st 106 µm long (paratypes 86–116(99) µm), 89 µm wide (paratypes 74–94(83) µm); 2nd 69 µm long (paratypes 62–74(69) µm), 54 µm wide (paratypes 44–57(51) µm wide); 3rd 267 µm long (paratypes 267–309(288) µm), 62 µm wide (paratypes 52–69(60) µm); 3rd segment parallel sided or weakly clubbed shaped; apical seta of antenna broken on holotype (paratypes 111–148(134) µm long, subapical seta 47 µm long (paratypes

40–49(46) µm); flagellate sensory seta near apical seta 32 µm long (paratypes 30–37(34) µm); microseta present near apex of antenna; unusual hair-like seta present near subapical seta; all segments of antennae covered with moderate number of spine-like, straight, apically acute setae, longest seta 20 µm long (paratypes 15–20(18) µm); first antennal segment with one capitate sensory setae on each side of segment; third antennal segment with 32 setae (paratypes with 28–40(35) setae) excluding those near apex. **Venter.** Labium 153 µm long (paratypes 148–183(163) µm). Stylet loop about as long as labium. Legs with front coxa 146 µm long (paratypes 131–156(146) µm), middle 156 µm long (paratypes 128–170(154) µm), hind 165 µm long (paratypes 141–173(164) µm); front trochanter-femur 329 µm long (paratypes 316–366(342) µm), middle 341 µm long (paratypes 322–384(359) µm), hind 391 µm long (paratypes 372–422(399) µm); front tibia-tarsus broken on holotype (paratypes 285–409(372) µm long), middle broken on holotype (paratypes 388–422(406) µm long), hind 415 µm long (paratypes 477–508(494) µm); front claw absent from holotype (paratypes 37–47(44) µm long), middle absent from holotype (paratypes 44–51(48) µm), hind 52 µm long (paratypes 44–52(49) µm); front claw digitules absent from holotype (paratypes 12–14(13) µm long), middle absent from holotype (paratypes 12–22(15) µm long), hind 10 µm long (paratypes 10–15(13) µm); legs with rows of robust setae; longest on trochanter-femur 22 µm long (paratypes 17–22(20) µm); with one flagellate sensory seta on tibia, 25 µm long (paratypes 20–30(25) µm); trochanter with 4 sensory pores on each surface. Wax plates absent from marginal areas of head and thorax except for small spine cluster laterad of antenna (plate 12) and normal plate between antennae (plate 11), with marginal wax band surrounding each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of coxae (plates 13, 17, and 18); without cluster of spines between hind legs and oviscap band; with remnants of plate 19 near body margin; with one band of spines within oviscap band. Thoracic spiracles with scattered quadrilocular pores loosely associated with each spiracular opening, each group containing 1–15(5) pores, 5–6(5) µm in diameter (several of these pores on dorsum); diameter of anterior thoracic spiracles 20–25(22) µm. Setae few, scattered in medial areas of thorax, with several setae near anterior edge of oviscap band (some are capitate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores surrounding vulva. Multilocular pores with 4–10 loculi around perimeter, one loculus in central hub; 8–9(8) µm in diameter; with quadrilocular pores predominant near anterior edge of spine band, partial row of multiloculars near anterolateral edge of spine band, also scattered around vulva and near oviscap band. Abdominal spiracles present with 2 pairs on each side of body anterior of oviscap band and one pair inside oviscap band near anterolateral angle; with sclerotized vestibule. **Dorsum.** Wax plates cover two-thirds of marginal area of surface; mediolateral thoracic plates small (plates 3, 5 and 6), covering most of mediolateral thoracic areas; medial area of thorax and abdomen without spines and pores; plate 3 divided medially. Spines at margin of wax plate 4 14 µm long (paratypes 12–15(14) µm), in middle of wax plate 20 µm long (paratypes 17–22(19) µm);

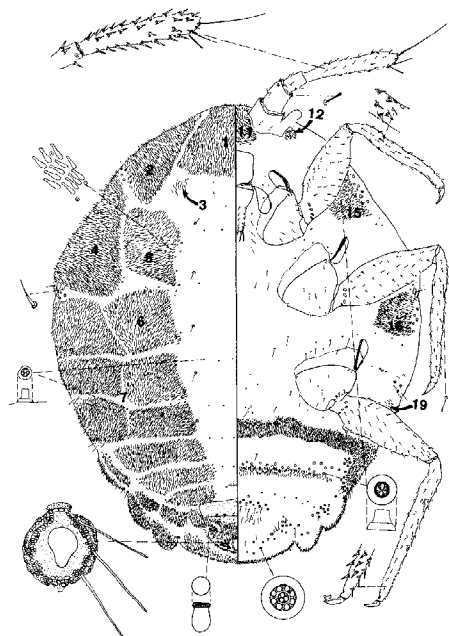


Fig. 3. *Ortheziola britannica* sp.n.

spines not apically. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 2–4(4) setae laterad of each thoracic spiracle, 24 µm long (paratypes 15–18(17) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 4 loculi around perimeter, one loculus in central hub; 6 µm in diameter (paratypes 5–7(6) µm); present in marginal areas of abdomen; also present in cluster near anal ring (this cluster sometimes with multiloculars with 5 loculi). Sclerotized plate 69 µm long (paratypes 49–75(66) µm), 260 µm long (paratypes 249–272(260) µm); with several setae at posterior edge of plate many with capitate apices. Anal ring with incomplete triple row of round pores (2–3 µm in diameter); longest seta 54 µm long (paratypes 40–55(49) µm); about equal to length of anal ring; ring 53 µm wide (paratypes 53–62(57) µm), 54 µm long (paratypes 54–72(62) µm). Thumb-like pores 5–6(5) µm long. Modified pores 5–7(6) µm long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola britannica* is very similar to *O. vejvodskyi* by having segmentally arranged spine plates on the abdomen, one band of spines in the ovisac band, four pairs of abdominal spiracles and reduced distribution of ventral spines. *Ortheziola britannica* differs by having wax plate 3 divided medially, small remnant of wax plate 19 present near body margin, apical antennal segment 267–309(288) µm long, sclerotized plate width 249–272(260) µm. *Ortheziola vejvodskyi* has wax plate 3 continuous across median, not divided medially; no remnant of wax plate 19 present near body margin; apical antennal segment 309–346(327) µm long; sclerotized plate width 269–291(282) µm long. It seems unlikely that this species is restricted to the U.K., but examination of all specimens of *O. vejvodskyi* in BMNH (about seventy specimens), PPI (about twenty specimens) and USNM (thirteen specimens) did not turn up any specimens from outside of the U.K. It is interesting that *O. britannica* and *O. vejvodskyi* coexist in the U.K., although the latter species is much more commonly collected.

This species is named for the localities from which it is found.

***Ortheziola ethiopiensis* Kozár & Miller, sp.n. (Fig. 4)**

**Type material.** *Holotype*, female, ETHIOPIA: Menageska, elevation 2800 m, from litter, 3.xii.1980 (A. Demeter) (no. 375 from the collection of S. Mahunka). Deposited in the PPI.

**Unmounted adult female.** Two-thirds of marginal surface of dorsum covered with white wax protrusions; broad band on midline of the dorsum bare, white. **Mounted adult female** (Fig. 4). *Holotype* 1.68 mm long; 1.25 mm wide. Size of antennal segments: 1st 102 µm long, 111 µm wide; 2nd 62 µm long, 58 µm wide; 3rd 448 µm long, 40 µm wide; 3rd segment nearly parallel sided; apical seta of antenna 125 µm long; subapical seta 80 µm long; flagellate sensory seta near apical seta 26 µm long; microseta present near apex of antenna, unusual hair-like seta absent from near subapical seta, all segments of antennae covered with large number of hair-like,

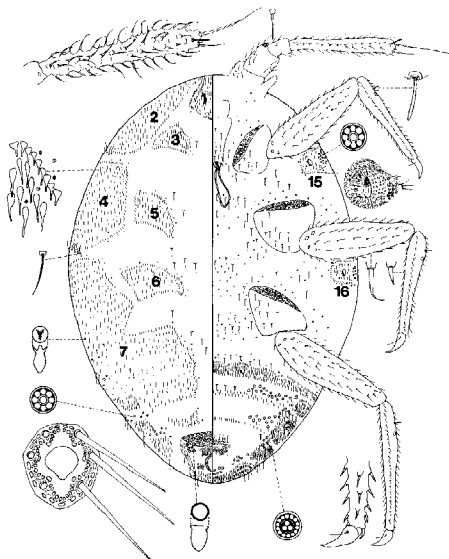


Fig. 4. *Ortheziola ethiopiensis* sp.n.

curved, apically acute setae, 40 µm long; first antennal segment with 2 hair-like sensory seta on each side of segment; third antennal segment with 57 setae. **Venter.** Labium 202 µm long. Stylet loop as long as labium. Legs with front coxa 240 µm long, middle 240 µm, hind 243 µm; front trochanter-femur 423 µm long, middle 490 µm, hind 540 µm; front tibia-tarsus 473 µm long, middle 514 µm, hind 622 µm; front claw 38 µm, middle 46 µm, hind 48 µm long; front claw digitules 16 µm, middle 16 µm, hind 16 µm; legs with rows of hair-like setae; longest on trochanter-femur 38 µm long; with one flagellate sensory seta on tibia, 19 µm long; trochanter with 3 sensory pores on each surface. Wax plates present in marginal areas near thoracic spiracles only (plates 15 and 16); with marginal wax band surrounding each thoracic spiracle; without triangular-shaped wax plates in front of each coxa (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with anterior band and posterior row of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 7–14, 8–10 locular pores, 6 µm in diameter; diameter of anterior thoracic spiracles 19 µm. Setae few, scattered in medial areas of thorax and around legs, with few setae near anterior edge of ovisac band (none of setae capitate), present near anterior row of multilocular pores, rare or absent near posterior row, present near vulva. Multilocular pores with 14 loculi around perimeter, 3 loculi in central hub; 10 µm in diameter; present in 2 incomplete double rows near anterior edges of spine bands, scattered around vulva. Abdominal



spiracles present near anterolateral angle of ovisac band; with lightly sclerotized vestibule. *Dorsum*. Wax plates cover two-thirds of surface; mediolateral thoracic plates unusually small (plates 3, 5 and 6), with large bare areas in mediolateral arca; broad medial and submedial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4 12 µm long, in middle of wax plates about 14 µm long; spines not apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 4 or 5 setae laterad of each thoracic spiracle, 17 µm long; also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8 loculi around perimeter, one loculus in central hub; 7 µm in diameter; present in marginal areas of abdomen; present near anal. Sclerotized plate 68 µm long, 256 µm wide; without setae on posterior edge of plate. Anal ring with incomplete double row of round pores (4 µm in diameter); longest seta 68 µm long; about same length as anal ring; ring: unmeasurable in length, 67 µm long, also not clearly seen. Thumb-like pores 5 µm long. Modified pores 2 µm long. Abdominal spiracle laterad of anal ring present.

*Comments*. *Ortheziola ethiopiensis* is similar to *O. matileferrerae* by having small mediolateral wax plates on the dorsum (plates 3, 5 and 6), the wax plates absent from around coxae (plates 13, 17 and 18), and the wax plates restricted to area around thoracic spiracles on the thoracic venter (plates 15 and 16). *Ortheziola ethiopiensis* differs from *O. matileferrerae* by having 7–14 multilocular pores near each thoracic spiracle, incomplete rows of multiloculars near the spine bands in the ovisac arca, and the setae on the antennae hairlike. *Ortheziola matileferrerae* has 1–3 multilocular pores near each thoracic spiracle, complete rows of multiloculars near the spine bands in the ovisac area and the setae on the antennae spinelike.

This species is named for the country from which it was collected.

***Ortheziola fercsii* Kozár & Miller, sp.n. (Fig. 5)**

*Type material*. *Holotype*, female, TANZANIA: Uluguru, elevation 1680 m, from litter of fern forest, 15.xi.1970 (T. Pócs) (no. 64 from the collection of S. Mahunka). Deposited in PPI.

*Unmounted adult female*. Most of dorsum covered with white, wax protrusions; narrow band on midline of the dorsum bare, white. *Mounted adult female* (Fig. 5). *Holotype* 2.34 mm long; 1.99 mm wide. Sizes of antennal segments: 1st 154 µm long, 122 µm wide; 2nd 82 µm long, 72 µm wide; 3rd 564 µm long, 76 µm wide; 3rd segment parallel sided; apical seta of antenna 218 µm long, subapical seta 80 µm long; flagellate sensory seta near apical seta 38 µm long; microseta absent from apex of antenna; with one unusual hair-like seta present near subapical seta; all segments of antennae covered with many robust, straight, apically acute, setae 32 µm long; first antennal segment with 2 clavate sensory setae on each side of segment; third antennal segment with 42 setae. *Venter*. Labium 230 µm long. Stylet loop shorter than labium. Legs with front coxa

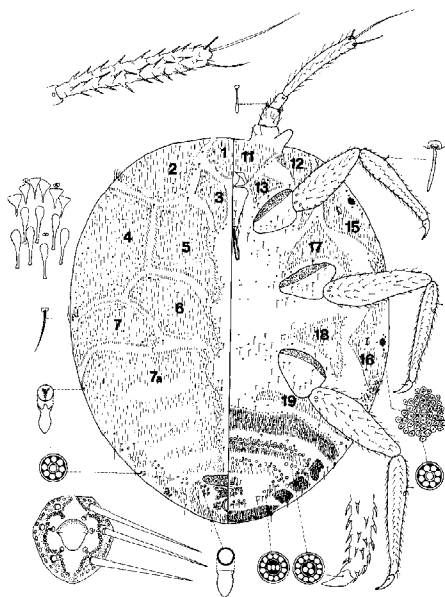


Fig. 5. *Ortheziola fercsii* sp.n.

250 µm long, middle 266 µm, hind 288 µm; front trochanter-femur 581 µm long, middle 415 µm, hind 706 µm; front tibia-tarsus 672 µm long, middle 730 µm, hind 830 µm; front claw 61 µm long, middle 48 µm, hind 64 µm; front claw digitules 23 µm long, middle 14 µm, hind 26 µm; legs with rows of robust setae, longest seta 26 µm long; with one flagellate sensory seta on each tibia, 34 µm long; trochanter with 3 sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal wax plates laterad of each thoracic spiracle (plates 15 and 16); with triangular-shaped wax plates in front of each coxa (plates 13, 17 and 18); with cluster of spines between hind legs and ovisac band; with 2 bands of spines within ovisac band. Thoracic spiracles with large clusters of multilocular pores laterad of each spiracular opening, each group containing 42–64, 8–10 locular pores, 6.0 µm in diameter; diameter of anterior thoracic spiracles 62 µm. Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some are clavate) and associated with multilocular pores. Multilocular pores with 12 loculi around perimeter, 3 loculi in central hub; 12 µm in diameter; present in 2 complete double rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present lateral of hind legs, anterior of ovisac band and near anterolateral angle of ovisac band; all have sclerotized vestibule. *Dorsum*. Wax plates cover most of surface; mediolateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; narrow medial area of

thorax and abdomen without spines and pores. Spines at margin of wax plate 4 16 µm long, in middle of wax plates about 23 µm long; spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 setae laterad of each thoracic spiracle; 20 µm long; also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8 loculi around perimeter, one loculus in central hub; 8 µm in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 93 µm long, 357 µm wide; with 2 setae on posterior edge of plate. Anal ring with incomplete double row of round pores (2 µm in diameter); with 6 setae; longest seta 73 µm long; about equal to length of anal ring; ring 67 µm wide, 74 µm long. Thumb-like pores 6 µm long. Modified pores 5 µm long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola fercsii* is similar to *O. benedictyae*; for a comparison of these species see the comments section of the latter species. *Ortheziola fercsii* also is similar to *O. williamsi* but differs by having the thoracic spiracular multilocular pores concentrated into tight clusters, with 42–64 pores near each spiracle; the apical antennal segment about 560 µm long; the tibia-tarsus of the hind leg about 830 µm long. *Ortheziola williamsi* has the thoracic spiracular multilocular pores scattered, with 2–7 pores near each spiracle; the apical antennal segment about 240 µm long; the tibia-tarsus of the hind leg about 380 µm long.

This species is named in honour of the first author's son Kozár Ferenc Krisztián (Hungary), acknowledging his help in scale insect collecting. Fercsi is a nickname of Ferenc.

### *Ortheziola giliomeei* Kozár & Miller, sp.n. (Fig. 6)

**Type material.** *Holotype*, female, TANZANIA (TANGANYIKA): Meru, from forest litter, 26.i.1966 (L. Szunyogh) (no. 8 from the collection of S. Mahunka). *Paratypes*, 4 females from the same collection, female, TANZANIA (TANGANYIKA): Meru, from forest litter, 1.ii.1966 (L. Szunyogh) (no. 11 from the collection of S. Mahunka); one female, TANZANIA (TANGANYIKA): Meru, from forest litter, 6.iii.1960 (L. Szunyogh) (no. 18 from the collection of S. Mahunka); 2 females, TANZANIA: Uluguru, from litter, 18.ii.1970 (T. Pócs). **Other material** (not paratypes). TANZANIA (TANGANYIKA): Meru, 1.ii.1966 (L. Szunyogh) (no. 104 from the collection of S. Mahunka); 2 females, TANZANIA: Uluguru, elevation of 2120 m, from litter, 30. vs. 1972 (T. Pócs) (no. 134 from the collection of S. Mahunka); 4 females, TANZANIA, Mossy, fern forest, from moss, 2.iv.1989 (T. Pócs) (no. 741 from the collection of S. Mahunka). Deposited in the PPI, HNHM, USNM and BMNH.

**Unmounted adult female.** Two-thirds of dorsum covered with white, wax protrusions; with 4 distinct mediolateral wax protrusions on each side of body; band on midline of dorsum bare (Fig. 17f). **Mounted adult female** (Fig. 6). 1.43 mm long (paratypes 1.43–1.80(1.62) mm); 1.10 mm wide (paratypes 1.06–1.40(1.27) mm). Size of antennal segments: 1st 90 µm long (paratypes 91–124(108) µm), 89 µm wide (paratypes 99–

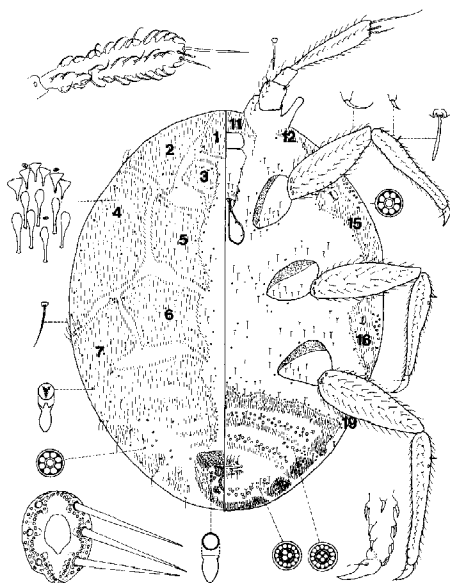


Fig. 6. *Ortheziola giliomeei* sp.n.

104(101) µm); 2nd 64 µm long (paratypes 74–84(81) µm), 48 µm wide (paratypes 52–59(55) µm); 3rd 320 µm long (paratypes 316–341(331) µm), 66 µm wide (paratypes 64–79(72) µm); 3rd segment slightly club shaped; apical seta of antenna 150 µm long (paratypes 146 µm), subapical seta 48 µm long (paratypes 47–54(52) µm); flagellate sensory seta near apical seta 25 µm long (paratypes 27–30(28) µm); microseta absent from apex of antenna, without unusual hair-like seta present near subapical seta, all segments of antennae covered with moderate number of robust, curved, apically acute setae, longest seta 28 µm long (paratypes 40–45(42) µm); first antennal segment with one hair-like sensory seta on each side of segment, third antennal segment with 48 setae (paratypes with 46–59(54) setae). **Venter.** Labium 147 µm long (paratypes 138–158(149) µm). Stylet loop about as long as labium or slightly shorter. Legs with front coxa 134 µm long (paratypes 131–138(135) µm), middle 160 µm (paratypes 141–168(155) µm), hind 163 µm (paratypes 148–158(153) µm); front trochanter-femur 373 µm long (paratypes 353–372(358) µm), middle 377 µm (paratypes 360–391(378) µm), hind 440 µm (paratypes 397–434(318) µm); front tibia-tarsus 432 µm long (paratypes 403–434(415) µm), middle 466 µm (paratypes 422–453(439) µm), hind 531 µm (paratypes 515–552(530) µm); front claw 48 µm (paratypes 46–49(48) µm) long, middle 48 µm (paratypes 49–52(50) µm), hind 48 µm (paratypes 49–53(51) µm); front claw digitules 16 µm long (paratypes 19–22(21) µm), middle 14 µm (paratypes 17–20(18) µm), hind 18 µm (paratypes 20–22(21) µm); legs with

rows of both robust and hair-like setae, longest on trochanter-femur 28 µm long (paratypes 32–36(34) µm); with one flagellate sensory seta on tibia, 17 µm long (paratypes 20–25(23) µm); trochanter with 3 sensory pores on each surface (paratypes sometimes with 4). Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of coxae (plates 13, 17 and 18) without cluster of spines between hind legs and ovisac band, with 2 bands of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 9–12 pores (paratypes 6–11(8) pores), pores with 8 loculi (paratypes with 8 or 9 loculi), 5 µm in diameter (paratypes 5–7(6) µm) (several of these pores on dorsum); diameter of anterior thoracic spiracles 24 µm (paratypes 23–28(26) µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some setae clavate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores surrounding vulva. Multilocular pores with 12–14 loculi around perimeter, 3 or 4 loculi in central hub; 10 µm in diameter (paratypes 9–10(10) µm); present in 2 complete double or triple rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; vestibule without sclerotization. *Dorsum*. Wax plates cover two-thirds of marginal area of surface; mediolateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; medial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4–14 µm long (paratypes 13–18(15) µm), in middle of wax plates about 19 µm long (paratypes 20–23(21) µm); spines in wax plate 7 capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3–5 setae laterad of each thoracic spiracle, 22 µm long (paratypes 25–28(26) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8 loculi around perimeter, one loculus in central hub; 5 µm in diameter (paratypes 5–7(6) µm); present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 82 µm long (paratypes 86–94(90) µm), 282 µm wide (paratypes 279–316(302) µm); with 2 setae on posterior edge of sclerotized plate with acute apex. Anal ring with incomplete double row of round pores (2 µm in diameter); longest seta broken (paratypes 42–67(55) µm); longer or shorter than length of anal ring; ring 48 µm wide (paratypes 49–62(53) µm), 55 µm long (paratypes 49–69(60) µm). Thumb-like pores 5 µm long. Modified pores 2 µm long (paratypes 4–5(4) µm). With abdominal spiracle laterad of anal ring.

*Comments.* *Ortheziola giliomeei* is similar to *O. nelliae* by having the wax plates absent from the dorsomedial areas of the thorax and abdomen (plates 8, 9 and 10) and the wax plates absent from around the coxae (plates 13, 17 and 18). *Ortheziola giliomeei* differs from *O. nelliae* by having 5–12 multilocular pores near each thoracic spiracle, the apical antennal segment about 330 µm long and the hind tibia-tarsus about 530 µm long. *Ortheziola nelliae* has 17–20 multilocular pores near each thoracic spiracle, the apical antennal segment about 580 µm long and the hind tibia-tarsus about 850 µm long.

The specimens from the last localities are not included in the type series because of differences in some characters, mainly the smaller number of spiracular multilocular pores. This species is named in honour of Dr Jan Giliomee, Department of Entomology and Nematology, University of Stellenbosch, South Africa, who provided valuable assistance in finding material of *Ortheziola* in South Africa and who has done outstanding research on adult male scale insects.

### *Ortheziola guineensis* Morrison, 1954 (Fig. 7)

*Ortheziola guineensis* Morrison, 1954:120.

*Type material.* Holotype, female, GHANA (= French Guinea): Nimba Mountains, 500–1700 m, in moss?, ix. 1946 (A. Villers). Deposited in USNM. *Other material.* One adult female and one immature, GHANA: Nyankpala, 5.viii.1968 (S. Endrödy-Younga) (no. 41 from the collection of S. Mahunka). Deposited in the PPI.

*Unmounted adult female.* Entire dorsum covered with white, wax protrusions; with 3 distinct mediolateral wax protrusions on each side of body; band on midline of dorsum with 4 wax

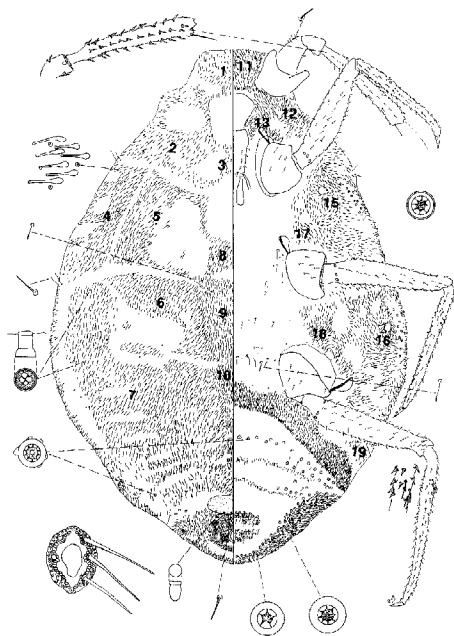


Fig. 7. *Ortheziola guineensis* Morrison.

protrusions (Fig. 17c). *Mounted adult female* (Fig. 7). 1.92 mm long; (other material 1.44 mm) 1.35 mm (other material 1.08 mm) wide. Size of antennal segments: 1st 124 µm (other material 110 µm) long, 96 µm (other material 90 µm) 90 wide; 2nd 82 µm (other material 61 µm) long, 59 µm (other material 49 µm) wide; 3rd 422 µm (other material 398 µm) long, 69 µm (other material 80 µm) wide; 3rd segment nearly parallel sided (other material blunted); apical seta of antenna broken on holotype (other material 153 µm long), subapical seta 54 µm (other material 49 µm) long; flagellate sensory seta near apical seta apparently broken (other material 31 µm); microseta present near apex of antenna; unusual hair-like seta absent from near subapical seta; all segments of antennae covered with moderate number of robust, straight, apically acute setae; longest seta 25 µm (other material 14 µm) long; first antennal segment with one hair-like sensory seta on each side of segment; third antennal segment with 52 (other material 48) setae excluding those near apex. *Venter*. Labium 170 µm (other material 166 µm) long. Stylet loop longer than labium. Leg with front coxa 135 µm (other material 126 µm) long, middle 148 µm (other material 150 µm), hind 197 µm (other material 170 µm); front trochanter-femur 453 µm (other material 473 µm) long, middle 465 µm (other material 498 µm), hind 558 µm (other material 564 µm); front tibia-tarsus 502 µm (other material 498 µm), middle 521 µm (other material 515 µm), hind 639 µm (other material 623 µm); front claw 53 µm (other material 50 µm) long, middle claw broken (other material 52 µm), hind 59 µm (other material 49 µm); front claw digitules 10 (other material 18 µm), middle broken (other material 18 µm), hind 12 µm (other material 14 µm); legs with rows of robust setae 22 µm (other material 19 µm) long; with 2–5 flagellate sensory setae on tibia µm (other material 1–2), 24 µm (other material 20 µm) long; trochanter with 3 or 4 sensory pores (other material 3 or 4) on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); with irregular triangular-shaped wax plates in front of coxae (plates 13, 17 and 18); with cluster of spines between hind legs and ovisac band; with 2 rows of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 9–12 (other material 9–13), 8 locular pores, 5 µm in diameter; diameter of anterior thoracic spiracles 37 µm (other material 34 µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some are capitate) (other material capitate not seen), several associated with anterior multilocular row, with one or 2 associated with second row, several more associated with posterior multilocular pores. Multilocular pores with 4–14 loculi around perimeter, one loculus in central hub; 7 µm (other material 7–8 µm) in diameter; present in 2 complete and incomplete double rows near anterior edges of spine band, scattered around vulva and near inner margin of ovisac band (other material second row almost complete). Abdominal spiracles present near anterior edge of ovisac band; with sclerotized vestibule. *Dorsum*. Wax plates cover all of surface; posterior 2 mediolateral thoracic plates large (plates 5 and 6), covering most of mediolateral thoracic areas, anterior mediolateral plate small (plate 3), leaving conspicuous bare area

(other material has no bare areas in the wax plates); without a medial area devoid of wax plates (see plates 8, 9 and 10), except for a few small areas, area 8 with few setae (other material with wax plate 8 large and complete); areas 9 and 10 tube-like, present on 2 planes when focusing with microscope. Spines at margin of wax plate 4 18 µm (other material 20 µm) long, in middle of wax plate about 21 µm long; spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 2 or 3 setae laterad of each thoracic spiracle, 30 µm (other material 22 µm) long; also present in very small numbers on other wax plates; some setae between wax plates slightly capitate. Multilocular pores with 8 or 9 loculi around perimeter, one loculus in central hub; 6 µm (other material 5 µm) in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 86 µm (other material 96 µm) long, 212 µm (other material 214 µm) wide; with several hair-like setae on posterior edge of plate. Anal ring with complete double row of round pores (3 µm in diameter) (other material 2 µm); longest seta 57 µm (other material 46 µm); about same length or shorter than anal ring; ring 56 µm (other material 50 µm) wide, 64 µm (other material 66 µm) long. Thumb-like pores 7 µm long. Quadriculular pores scattered over surface, tubular in lateral view, 5 µm (other material 4 µm) long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola guineensis* is similar to *O. loebli* and *O. kosztarabi* by having wax plates in the dorsomedial areas of the thorax and abdomen (plates 8, 9 and 10). *Ortheziola guineensis* differs from *O. loebli* by having a large bare area in the ventromedial area of the thorax and 2–5 flagellate sensory setae on each tibia. *Ortheziola loebli* has a very narrow bare area in the ventromedial area of the thorax and one or 2 sensory setae on each tibia. *Ortheziola guineensis* differs from *O. kosztarabi* by having a conspicuous bare area on the dorsum posterior of the antenna, the wax plates restricted to anterior of coxae (plates 13, 17 and 18), 2–5 sensory setae on each tibia, the apical antennal segment less than 450 µm long and the hind tibia-tarsus less than 700 µm long. *Ortheziola kosztarabi* has no conspicuous bare area on the dorsum posterior of the antenna, wax plates surrounding coxae (plates 13, 17 and 18), 2 or 3 sensory setae on each tibia, the apical antennal segment more than 500 µm long and the hind tibia-tarsus greater than 730 µm long.

We suspect that the holotype of this species is an aberrant specimen in terms of the unusual bare areas in the dorsal wax plates. The only other known adult specimen of this species has the dorsal plates normally developed. The structure of the dorsomedial wax plates is quite unusual in that they seem to be tube-like. When focusing with the compound microscope from the dorsum to the venter, the first plane of focus is the dorsal surface of the plate which has about half as many spines as the next surface toward the venter which is the same shape as the dorsal surface; focusing downward eventually brings the focal plane to the venter. This pattern is found on all three specimens of the species. We examined the same wax plates on *O. loebli* and *O. kosztarabi* but they do not show the tube-like structure of *O. guineensis*.

***Ortheziola jermiyi* Kozár & Miller, sp.n. (Fig. 8)**

*Type material.* *Holotype*, female (marked), with a paratype on one slide, TANZANIA: Uluguru, Morogor Teachers College, from litter of gallery forest, elevation 670 m, 9.vii.1972 (T. Pócs) (no. 115 from the collection of S. Mahunka). *Paratypes*, 5 females from the same collection; one female, TANZANIA: Uluguru, from litter of tropical forest, 5.xi.1970 (T. Pócs) (no. 68 from the collection of S. Mahunka); 3 females, TANZANIA: Uluguru, from litter of fern forest, elevation 1800 m, 21.ix.1971 (T. Pócs) (no. 84 from the collection of S. Mahunka); 4 females, TANZANIA: Uluguru, Morogor River, from litter of gallery forest, elevation 600 m, 1.v.1972 (T. Pócs) (no. 107 from the collection of S. Mahunka); 6 females, TANZANIA: Uluguru, Morogor River, from litter of gallery forest, elevation 670 m, 9.vii.1972 (T. Pócs) (no. 110 from the collection of S. Mahunka); 2 females, TANZANIA: Uluguru, Morogor Teachers College, from litter of *Aframomum* in gallery forest, elevation 700 m, 9.ii.1972 (T. Pócs) (no. 113 from the collection of S. Mahunka); 6 females, TANZANIA: Uluguru, Morogor River, from litter of gallery forest, elevation 600 m, 1.v.1972 (T. Pócs) (no. 116 from the collection of S. Mahunka); 2 females, TANZANIA: Uluguru, Mt Kimooza, from litter of *Pandanus* in rainforest, 18.ii.1972 (T. Pócs) (no. 162 from the collection of S. Mahunka); 3

females, TANZANIA: Mombo, Tanga region, from litter of forest, 21.ii.1987 (S. Mahunka, T. Pócs, & A. Zicsi) (no. 652 from the collection of S. Mahunka); one female, UGANDA: Ruwenzori Exp., uml. E. Y. F. R. Lab., Bundibugyo, litter of hardwood stand, 2.ix.1952 (G. O. Evans) (no. 240) (No. BM 1952-566, CIE, 11419) from the collection of The Natural History Museum, London, courtesy of D. J. Williams and J. Martin); 3 females, UGANDA: Busowa Falls, litter and soil from riverine forest 1965 (W. C. Block) from the collection of The Natural History Museum, London, courtesy of D. J. Williams and J. Martin); 4 females, SOUTH AFRICA: Nelspruit National Reserve, 18.xii.1986 (no. 4898 from the collection of S. Endrödy-Younga). Deposited in the PPI, USNM and BMNH.

*Unmounted adult female.* Marginal half of dorsum covered with white wax protrusions; broad band on midline of the dorsum bare, white. *Mounted adult female* (Fig. 8). *Holotype* 1.43 mm long (paratypes 1.27–1.34(1.30) mm); 1.17 mm wide (paratypes 1.01–1.14(1.08) mm). Sizes of antennal segments: 1st 74 µm long (paratypes 89–91(90) µm), 64 µm wide (paratypes 79–84(82) µm); 2nd 60 µm long (paratypes 67 µm), 29 µm wide (paratypes 37–40(38) µm); 3rd 211 µm long (paratypes 232–244(238) µm), 43 µm wide (paratypes 44–59(52) µm); 3rd segment club shaped; apical seta of antenna slender, broken in holotype (paratypes 164–180(170) µm); subapical seta 36 µm long (paratypes 44 µm); flagellate sensory seta near apical seta 22 µm long (paratypes 25–32(28) µm); unusual hair-like seta present near subapical seta; microseta absent from apex of antenna; with one unusual hair-like seta present near subapical seta; all segments of antennae covered with small number of robust, curved, apically acute setae, longest seta 24 µm long (paratypes 22–27(24) µm); first antennal segment with one hair-like sensory seta on each side of segment (paratypes 0 or 1(1) seta); third antennal segment with setae excluding apical ones (paratypes 25–40(32) setae). *Venter.* Labium 128 µm long (paratypes 124–133(128) µm). Stylet loop shorter than labium. Legs with front coxa 86 µm long (paratypes 114–116(115) µm), middle 96 µm (paratypes 124–128(126) µm), hind 120 µm (paratypes 131–133(132) µm); front trochanter-femur 288 µm long (paratypes 291–310(300) µm), middle 314 µm (paratypes 310–316(313) µm), hind 336 µm (paratypes 341–366(348) µm); front tibia-tarsus 317 µm long (paratypes 322 µm), middle 326 µm (paratypes 322–329(326) µm), hind 415 µm (paratypes 378–403(396) µm); front claw 35 µm long (paratypes 11–16(14) µm), middle 37 µm (paratypes 52 µm), hind 42 µm (paratypes 40–54(48) µm); front claw digitules broken (paratypes 11–16(14) µm), middle claw digitules broken (paratypes 15 µm), hind 11 µm (paratypes 15 µm); legs with rows of robust setae, longest seta of trochanter-femur 17 µm long (paratypes 30–35(32) µm); with one flagellate sensory seta on tibia, 10 µm long (paratypes 17–19(18) µm); trochanter with 3 sensory pores on each surface (paratypes 3 or 4(3) pores). Wax plates present in marginal areas of head and thorax; with wide marginal wax plate laterad of each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of each coxa (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with 2 bands of spines within ovisac

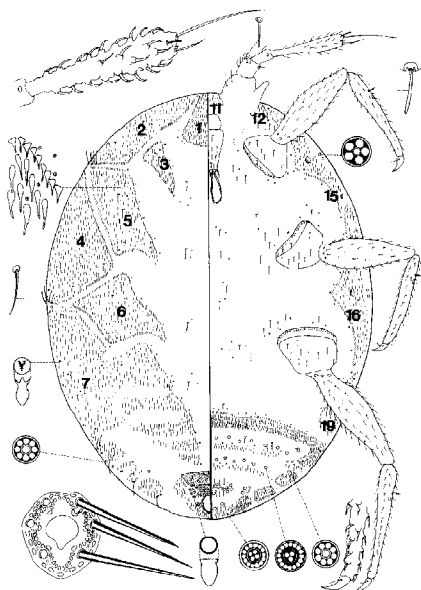


Fig. 8. *Ortheziola jermiyi* sp.n.

band (posterior band composed of 2 rows of spines). Thoracic spiracles with small clusters of multilocular pores laterad of each spiracular opening, each group containing 2 (paratypes 0–3(2) pores), 5 or 6 locular pores, 5 µm in diameter (paratypes 5–6(5) µm); diameter of anterior thoracic spiracles 20 µm (paratypes 16–19(18) µm). Setae few, scattered in medial areas of thorax and around legs, with few setae near anterior edge of ovisac band (none are clavate), rare or absent from rows of multilocular pores, present near vulva. Multilocular pores with 8–16 loculi around perimeter, 1–4 loculi in central hub; 8 µm in diameter (paratypes 8–9(8) µm); present in 2 complete single rows near anterior edges of spine bands, paratypes with posterior row sometimes incomplete medially, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; vestibule of spiracle without sclerotization. *Dorsum*. Wax plates cover only marginal areas of surface; mediolateral thoracic plates small (plates 3, 5 and 6), leaving conspicuous bare areas on mediolateral thoracic region; broad medial and submedial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4–14 µm long (paratypes 10–20(15) µm), in middle of wax plates 22 µm long (paratypes 20–22(21) µm); spines without capitale apex. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 4 setae laterad of thoracic spiracles (paratypes 4 or 5(4) setae), longest seta 19.2 µm (paratypes 18–22(20) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8 loculi around perimeter (paratypes 7–12(8) loculi), one loculus in central hub; 8 µm in diameter; present in marginal areas of abdomen; with 2–4 in 'cluster' near anal ring. Sclerotized plate 74 µm long (paratypes 74–84(79) µm), 227 µm wide (paratypes 240–264(252) µm); with or without 2 setae on posterior edge of plate. Anal ring with incomplete double row of round pores (4 µm in diameter (paratypes 2 µm); longest seta 45.6 µm long (paratypes 40–42(41) µm); longer than length of anal ring; ring 36 µm wide (paratypes 44 µm), 38 µm long. Thumb-like pores 5 µm long (paratypes 5–6(5) µm). Modified pores 6 µm long (paratypes 5–6(5) µm). Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola jermeyi* is similar to *O. matileferreroae* by having no spines surrounding coxae, a broad dorsomedial bare area and few multilocular pores near the thoracic spiracles. *Ortheziola jermeyi* differs by having the spiracular multilocular pores with 5 or 6 loculi, wax plates present along the ventral body margin (plates 12, 15, 16 and 19), the apical antennal segment about 240 µm long and the trochanter-femur of the hind leg about 350 µm long. *Ortheziola matileferreroae* has the spiracular multilocular pores with 8–10 loculi, the wax plates restricted to the ventral area surrounding the thoracic spiracles (plates 15 and 16 only), the apical antennal segment about 360 µm long and the trochanter-femur of the hind leg about 430 µm long.

This species is named in honour of Dr Tibor Jermey, former Director of the Plant Protection Institute, Hungarian Academy of Sciences (Hungary), acknowledging his help in the first author's entomological studies.

### *Ortheziola kosztarabi* Kozár & Miller, sp.n. (Fig. 9)

*Type material.* *Holotype*, female, ANGOLA: Luna et Barros Machado, from litter of gallery forest, 20.iv.1962 (R. Mussaloniuca) (no. 850 from the collection of S. Mahunka). *Paratype*, one female from the same collection. Deposited in the PPI and USNM.

*Unmounted adult female.* Entire dorsum covered with white, wax protrusions; with 4 distinct mediolateral wax protrusions on each side of body; band on midline of the dorsum with 4 triangular wax protrusions. *Mounted adult female* (Fig. 9). *Holotype* 1.66 mm long (paratype 1.91 mm); 0.95 mm wide (paratype 1.38 mm). Sizes of antennal segments: 1st 128 µm long (paratype 173 µm), 128 µm wide (paratype 128 µm); 2nd 86 µm long (paratype 111 µm), 80 µm wide (paratype 79 µm); 3rd 564 µm long (paratype 533 µm), 112 µm wide (paratype 74 µm); 3rd segment nearly parallel sided; apical seta of antenna 115 µm long (paratype 124 µm); subapical seta 62 µm long (paratype 75 µm); flagellate sensory seta near apical seta 24 µm long (paratype 32 µm); microseta absent from apex of antenna; with 2 unusual hair-like seta present near subapical seta; all segments of antennae covered with many robust, straight, apically acute setae, longest seta 20 µm long (paratype 37 µm); first antennal segment with one sensory hair-like seta on one side; third segment with 69 setae (paratype with 60 setae). *Venter.* Labium 218 µm long (paratype 222 µm). Stylet loop shorter than labium. Legs with front coxa 166 µm long

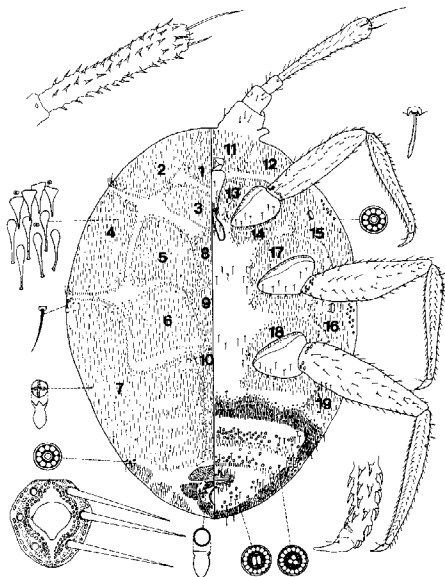


Fig. 9. *Ortheziola kosztarabi* sp.n.

(paratype 198 µm), middle 208 µm (paratype 185 µm), hind 234 µm (paratype 205 µm); front trochanter-femur 581 µm long (paratype 620 µm), middle 605 µm (paratype 651 µm), hind 664 µm (paratype 700 µm); front tibia-tarsus 598 µm long (paratype 676 µm), middle 623 µm (paratype 707 µm), hind 763 µm (paratype 806 µm); front claw 46 µm long (paratype 59 µm), middle 48 µm (paratype 57 µm), hind 52 µm (paratype 59 µm); front claw digitules broken (paratype 21 µm), middle broken (paratype 22 µm); hind 18 µm (paratype 20 µm); legs with rows of robust setae 17 µm long (paratype 40 µm); with 2 flagellate sensory seta on tibia (paratype with 2 or 3), 19 µm long (paratype 30 µm); trochanter with 4 sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); with oval-shaped wax plates surrounding coxae (plates 13, 17 and 18); with cluster of spines between hind legs and ovisac band; with one anterior band and one posterior row of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 5–12, 8–10 locular pores, 6–9 µm in diameter; diameter of anterior thoracic spiracles 29 µm (paratype 37 µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some of setae clavate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores. Multilocular pores with 14–16 loculi around perimeter, 2 or 3 loculi in central hub; 8 µm in diameter (paratype 8–9 µm); present in 2 complete double or triple rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; with sclerotized vestibule. *Dorsum*. Wax plates cover all of surface; medio-lateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; without medial area devoid of wax plates, this area with 3 triangular wax plates (plates 8, 9 and 10). Spines at margin of wax plate 4 17 µm long, in middle of wax plates about 19 µm long (paratype 25 µm); spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 4 or 5 setae laterad of each thoracic spiracle (paratype 3 or 4 setae), 22 µm long (paratype 35 µm); also present in very small numbers on other wax plates. Multilocular pores with 10 loculi around perimeter (paratype with up to 13 loculi), one loculus in central hub (paratype with one or 2 central loculi); 6 µm in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 90 µm long (paratype 57 µm), 256 µm wide (paratype 203 µm); without setae on posterior edge of plate. Anal ring with complete triple row of round pores (2–4 µm in diameter); longest seta 50 µm (paratype 49 µm); shorter than length of anal ring; ring 66 µm wide (paratype 54 µm), 72 µm long (paratype 54 µm). Thumb-like pores 2 µm long (paratype 7 µm). Modified pores 5 µm long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola kosztarabi* is similar to *O. guineensis*. For a comparison of these species see the comments section of the latter species. *Ortheziola kosztarabi* is also similar to *O. loebli* but differs by having a large bare area in the

ventromedial area of the thorax, 2 or 3 sensory setae on each tibia and the quadrilocular pores absent. *Ortheziola loebli* has a very narrow bare area in the ventromedial area of the thorax, one sensory setae on each tibia and quadrilocular pores predominant.

This species is named in honour of Dr Michael Kosztarab (Virginia Polytechnic Institute and State University, Blacksburg, Virginia, U.S.A.) acknowledging his help in our coccidological studies.

### *Ortheziola loebli* Richard (Fig. 10)

*Ortheziola loebli* Richard, 1990: 226.

*Type material.* One paratype female labelled as follows: left label 'NEPAL: Mangsingma/forêt (2300 m)/11.IV.1984/I. Löbl réc. (13) MNHN-9775/3'; right label 'Ortheziola loebli Rich./1987/PARATYPE/adult/tarnisarge femelles/mortes et mousses'. Another adult female labelled with the left label: 'NEPAL: Phulchoki/district de Katmandou/(2650 m)/13.X.1983/I. Löbl réc. (34)/MNHN-9683/6a'; right label 'Ortheziola loebli Rich./1987/PARATYPE/adult/exchange/M.N.H.N.'. Deposited in the MNHN and USNM. Remaining types are in MNHN.

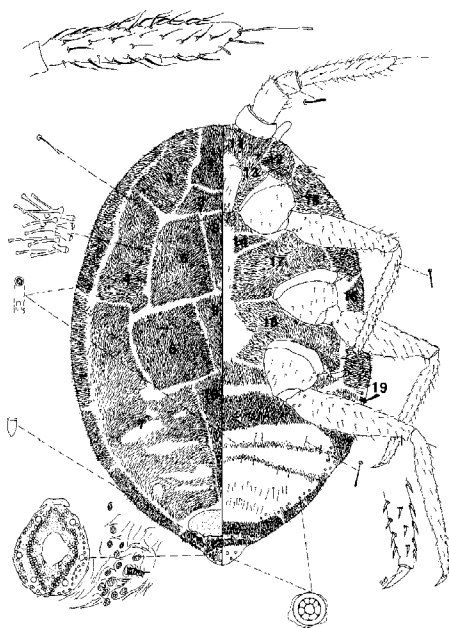


Fig. 10. *Ortheziola loebli* Richard.

**Unmounted adult female.** Entire dorsum covered with white, wax protrusions; with 3 distinct mediolateral wax protrusions on each side of body; band on midline of dorsum with 4 wax protrusions. **Mounted adult female** (Fig. 10). Adult female 1.84–1.92(1.88) mm long; 1.28–1.44(1.36) mm wide. Sizes of antennal segments: 1st 148–156(152)  $\mu$ m long, 116–128(122)  $\mu$ m wide; 2nd 74–84(79)  $\mu$ m long, 76–82(79)  $\mu$ m wide; 3rd 471–490(482)  $\mu$ m long, 74–79(76)  $\mu$ m wide; 3rd segment nearly parallel sided; apical seta of antenna 141–163(152)  $\mu$ m; subapical seta 74–79(76)  $\mu$ m long; flagellate sensory seta near apical seta 32–36(34)  $\mu$ m long; microseta absent from apex of antenna; without unusual hair-like seta near subapical seta; with several small setae near posterior edge of antenna; all segments of antennae covered with many hair like, curved, apically acute setae, longest seta 52–67(60)  $\mu$ m long; first antennal segment with 2 capitate sensory setae on each side; third segment with 53–56(54) setae. **Venter.** Labium 165–225(195)  $\mu$ m long. Stylet loop shorter than labium. Legs with front coxa 210–251(230)  $\mu$ m long, middle 212–247(230)  $\mu$ m, hind 222–240(231)  $\mu$ m; front trochanter-femur 477–508(492)  $\mu$ m long, middle 515–546(530)  $\mu$ m, hind 595–614(604)  $\mu$ m; front tibia-tarsus 533–539(536)  $\mu$ m long, middle 552–583(568)  $\mu$ m, hind 694–707(700)  $\mu$ m; front claw 64–74(69)  $\mu$ m long, middle 52–75(64)  $\mu$ m, hind 69–72(70)  $\mu$ m; front claw digitules 20–27(24)  $\mu$ m long, middle 22–25(24)  $\mu$ m, hind 20–30(25)  $\mu$ m; legs with rows of robust setae, longest seta on trochanter femur 40–47(44)  $\mu$ m; with 1 or 2(1) flagellate sensory seta on tibia, 26–35(30)  $\mu$ m long; trochanter with 3 or 4(4) sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); with large rectangular-shaped wax plates surrounding coxae (plates 13, 17 and 18); with cluster of spines between hind legs and ovisac band; with 2 bands of spines within ovisac band. Thoracic spiracles usually without associated multilocular pores, one spiracle with one such pore, with 8 loculi, 22  $\mu$ m in diameter; diameter of anterior thoracic spiracles 37–39(38)  $\mu$ m. Setae few, with several setae near anterior edge of ovisac band (some of setae clavate), several associated with anterior and posterior multilocular rows. Multilocular pores with 8 or 9 loculi around perimeter, one loculus in central hub; 7  $\mu$ m in diameter; absent near anterior edges of spine bands, scattered along lateral edge of ovisac band. Abdominal spiracles present anterior of ovisac band; without sclerotized vestibule. **Dorsum.** Wax plates cover all of surface; mediolateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; without medial area devoid of wax plates, this area with 3 triangular wax plates (plates 8, 9 and 10). Spines at margin of wax plate 4 12–14(13)  $\mu$ m long, in middle of wax plates 22–25(24)  $\mu$ m long; spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 setae laterad of each thoracic spiracle, 23–24(24)  $\mu$ m long; also present in very small numbers on other wax plates. Multilocular pores usually absent except present in cluster near anal ring. Sclerotized plate 131–161(146)  $\mu$ m long, 321–371(346)  $\mu$ m wide; with 2 small setae on posterior edge of plate. Anal ring with complete triple or quadruple row of round pores (4–5  $\mu$ m in diameter); longest seta

67  $\mu$ m; shorter than length of anal ring; ring 77–86(82)  $\mu$ m wide, 72–76(74)  $\mu$ m long. Thumb-like pores 6–10(8)  $\mu$ m long. Modified pores (quadrilocular pores) 7  $\mu$ m long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola loebli* is similar to *O. guineensis* and *O. kosztarabi*. For a comparison of these species see the comments section of the latter species.

### *Ortheziola madecassa* Mamet (Fig. 11)

*Ortheziola madecassa* Mamet, 1955: 123.

**Type material.** From the syntypes we have selected as lectotype an adult female mounted alone on a slide in the hand writing of Mamet as follows: left label, 'Ortheziola/madecassa/Mamet/on?/MADAGASCAR TYPE Ru/(Ambohitritondrona)/Coll. Vadom no. 384/TYPE'; right label 'MNHN – 8722/1'. A third label has been added to the back of the slide: 'Ortheziola madecassa/Mamet/LECTOTYPE/designated by/Kozár and Miller'. There are two paralectotype slides each containing one adult female. All three slides are deposited in the MNHN (the lectotype and one other slide were examined).

**Unmounted adult female.** '.... (from alcoholic specimens) with marginal wax plates; ovisac short, straight, apparently not fluted dorsally, consisting of pure white wax of a brittle nature'

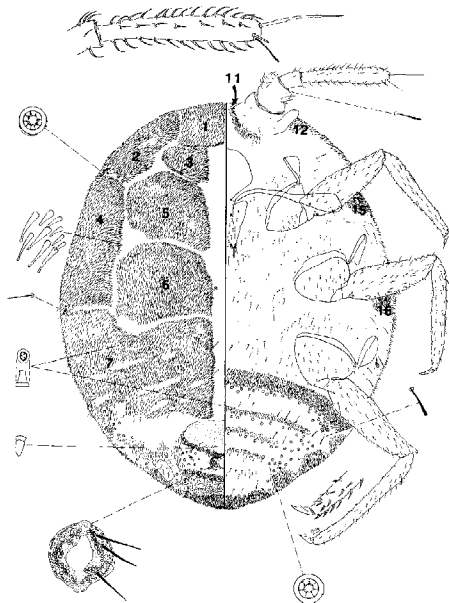


Fig. 11. *Ortheziola madecassa* Mamet.



(Mamet, 1955). *Mounted adult female* (Fig. 11). 1.44–1.62 (1.53) mm long; 1.19–1.42 (1.30) mm wide. Size of antennal segments: 1st 124–126 (125)  $\mu$ m long, 116–126 (121)  $\mu$ m wide; 2nd 72–74 (73)  $\mu$ m long, 59–64 (62)  $\mu$ m wide; 3rd 335–341 (338)  $\mu$ m long, 62–64 (63)  $\mu$ m wide; 3rd segment parallel sided or slightly club-shaped; apical seta of antenna 185  $\mu$ m long, subapical seta 74–75 (74)  $\mu$ m long; flagellate sensory seta near apical seta 32–35 (34)  $\mu$ m long; microseta absent from apex of antenna; without unusual hair-like seta near subapical seta; all segments of antennae covered with moderate number of spine-like, curved setae, longest seta 27–37 (32)  $\mu$ m long; first antennal segment with 2 capitate sensory setae on each side of segment; third antennal segment with 47–58 (52) setae excluding those near apex. *Venter*. Labium 175–178 (176)  $\mu$ m long. Stylet loop longer than length of labium. Legs with front coxa 136–141 (138)  $\mu$ m long, middle 156–158 (157)  $\mu$ m, hind 165–180 (172)  $\mu$ m; front trochanter-femur 347–366 (356)  $\mu$ m long, middle 372–378 (375)  $\mu$ m, hind 403–415 (409)  $\mu$ m; front tibia-tarsus 378–384 (381)  $\mu$ m long, middle 403–415 (409)  $\mu$ m, hind 496–502 (499)  $\mu$ m; front claw 47–49 (48)  $\mu$ m long, middle 52–54 (53)  $\mu$ m, hind 53–54 (54)  $\mu$ m; front claw digitules 20  $\mu$ m long, middle 15  $\mu$ m, hind 10–19 (14)  $\mu$ m; legs with rows of robust setae; longest on trochanter-femur 32–35 (34)  $\mu$ m long; with 1–3 (1) flagellate sensory seta on tibia, 27  $\mu$ m long; trochanter with 4 sensory pores on each surface. Wax plates absent from marginal areas of head and thorax except for small spine cluster laterad of antenna (plate 12) and normal plate between antennae (plate 11), with marginal wax band surrounding each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of coxae (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with one anterior band and one posterior row of spines within ovisac band. Thoracic spiracles with multilocular pores associated with each spiracular opening, with 8–10 (8) loculi, each group containing 8–15 (11) pores, 6–7 (7)  $\mu$ m in diameter (several of these pores on dorsum); diameter of anterior thoracic spiracles 23–25 (24)  $\mu$ m. Setae few, scattered in medial areas of thorax, with setae near anterior edge of ovisac band (some clavate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores surrounding vulva. Multilocular pores with 8–10 (8) loculi around perimeter, one loculus in central hub, 8–10  $\mu$ m in diameter; present in complete single rows near anterior edges of spine bands, scattered around vulva. Abdominal spiracles present anterior of ovisac band and near anterolateral angle of ovisac band; vestibule not sclerotized and very cryptic. *Dorsum*. Wax plates cover most of surface; mediolateral thoracic plates large (plates 3, 5 and 6), covering most of mediolateral thoracic areas; narrow medial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4 12  $\mu$ m long, in middle of wax plates 20–21 (20)  $\mu$ m long; spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 (4) setae laterad of each thoracic spiracle, 24  $\mu$ m long. Multilocular pores with 8 loculi around perimeter, one loculus in central hub present in cluster near anal ring, present in lateral areas of posterior abdominal segments. Sclerotized plate 99–106 (102)  $\mu$ m long, 279–

285 (282)  $\mu$ m wide; with 2–4 (2) setae near posterior edge of plate (sometimes capitate); also with conspicuous sclerotized plate posterior of anal ring and with smaller plate laterad of this plate. Anal ring with incomplete triple row of round pores (2–3  $\mu$ m in diameter); longest seta 49–79 (64)  $\mu$ m long; longer than length of anal ring; ring 54  $\mu$ m wide, 54–59 (56)  $\mu$ m long. Thumb-like pores 7  $\mu$ m long. Small sized pores scattered over surface, predominantly with 3 loculi which are clearly visible, 5  $\mu$ m long. Abdominal spiracle not seen in centre of multilocular cluster laterad of anal ring but could be present.

*Comments*. *Ortheziola madecassa* differs from all other species in the genus by having an additional sclerotized dorsal plate posterior of the anal ring.

### *Ortheziola mahunkai* Kozár & Miller, sp.n. (Fig. 12)

*Type material*. *Holotype*, female (marked, with one paratype on the same slide), ZAIRE: Bukavu, Biega, from the litter of *Arundinaria alpina*, elevation 2400 m, 28–30.viii.1991 (T. Pócs) (no 91128) (no. 771 from the collection of S. Mahunka). *Paratypes*, 7 females from the same collection. Deposited in the PPI, HNHM, USNM and BMNH.

*Unmounted adult female*. Most of dorsum covered with white, wax protrusions; with 3 distinct mediolateral wax protrusions on each side of body; band on midline of the dorsum bare (Fig. 17c). *Mounted adult female* (Fig. 12).

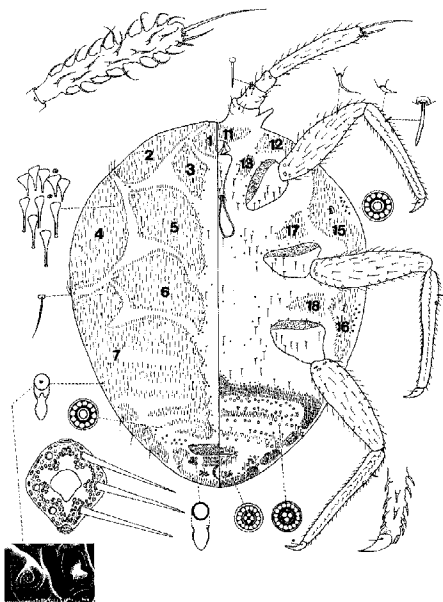


Fig. 12. *Ortheziola mahunkai* sp.n.

Holotype 1.98 mm long (paratypes 1.88–2.06(1.97) mm); 1.58 mm wide (paratypes 1.71–1.72(1.72) mm). Size of antennal segments: 1st 147 µm long (paratypes 163–165(164) µm), 124 µm wide (paratypes 111–146(128) µm); 2nd 83 µm long (paratypes 99–124(112) µm), 64 µm wide (paratypes 64 µm); 3rd 498 µm long (paratypes 471–490(480) µm), 67 µm wide (paratypes 64–67(66) µm); 3rd segment nearly parallel sided; apical seta of antenna 176 µm long (paratypes 195–198(196) µm), subapical seta 64 µm long (paratypes 69 µm); flagellate sensory seta near apical seta 29 µm long (paratypes 38 µm); microseta present near apex of antenna; unusual hair-like seta absent from near subapical seta; all segments of antennae covered with small number of hair-like, curved, apically capitate setae; longest seta 67 µm long (paratypes 74–79(76) µm); first antennal segment with 2 or 3 hair-like sensory seta on each side of segment (paratypes with 0–3(2) on each side of antenna; third antennal segment with 43 setae (paratypes with 32–42(37) setae). *Venter*. Labium 160 µm long (paratypes 160–165(162) µm). Stylet loop about equal to length of labium. Legs with front coxa 166 µm long (paratypes 158–170(164) µm), middle 176 µm (paratypes 185–203(194) µm), hind 208 µm (paratypes 205–207(206) µm); front trochanter-femur 498 µm long (paratypes 477–484(480) µm), middle 515 µm (paratypes 508–539(523) µm), hind 598 µm (paratypes 558–564(561) µm); front tibia-tarsus 548 µm long (paratypes 527–539(533) µm), middle 564 µm (paratypes 527–558(542) µm), hind 664 µm (paratypes 639–657(648) µm); front claw 54 µm long (paratypes 57–58(58) µm), middle 60 µm (paratypes 54–57(56) µm), hind 60 µm (paratypes 62 µm); front claw digitules 30 µm long (paratypes 22–30(26) µm), middle digitules broken on holotype (paratypes 27 µm), hind 26 µm (paratypes 30 µm); legs with rows of robust setae on distal half of tibia, with hair-like setae on anterior half of tibia and on femur; longest on trochanter-femur 84 µm long (paratypes 91–93(92) µm); with one flagellate sensory seta on tibia, 31 µm long (paratypes 28–33(30) µm); trochanter with 3 sensory pores on each surface. Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); with triangular-shaped wax plates in front of coxae (plates, 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with one anterior band and one posterior row of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 6–10, 10–12-locular pores, 7 µm in diameter (one or 2 of these pores on dorsum); diameter of anterior thoracic spiracles 38 µm (paratypes 30 µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (rarely with setae clavate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores near vulva. Multilocular pores with 14–16 loculi around perimeter, 3 or 4 loculi in central hub; 11 µm in diameter (paratypes 11–12(12) µm); present in 3 complete and incomplete rows near anterior and posterior edges of spine bands, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; with sclerotized vestibule. *Dorsum*. Wax plates cover most of surface; mediolateral thoracic plates large (plates

3, 5 and 6), covering most of mediolateral thoracic areas; narrow medial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4 19 µm long (paratypes 18–22(20) µm), in middle of wax plates about 21 µm long (paratypes 25–26(26) µm); spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3–5 setae laterad of each thoracic spiracle, 29 µm long (paratypes 36–49(43) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 10–12 loculi around perimeter, one loculus in central hub; 7 µm in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 74 µm long (paratypes 67 µm), 316 µm wide (paratypes 310–316(313) µm); without setae on posterior edge of plate. Anal ring with incomplete triple row of round pores (2 µm in diameter); longest seta not seen clearly (paratypes 74 µm); longer than length of anal ring; ring 60 µm wide (paratypes 59–64(62) µm), 65 µm long (paratypes 42–54(48) µm). Thumb-like pores 8 µm long (paratypes 7–11(9) µm). Modified pores 4 µm long (paratypes 4–5(5) µm). The SEM photo (Fig. 12) shows 2 kinds of modified pores, which cannot be seen clearly in light microscope slides. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola mahunkai* is similar to *O. williamsi* by having a narrow medial bare area on dorsum and large mediolateral wax plates on the dorsum of the thorax (plates 3, 5 and 6). *Ortheziola mahunkai* differs from *O. williamsi* by having three rows of pores in the anal ring, hairlike setae on the antennae, the apical antennal segment about 480 µm long and the tibia-tarsus about 650 µm long. *Ortheziola williamsi* has two rows of pores in the anal ring, spinelike setae on the antennae, the apical antennal segment about 240 µm long and the tibia-tarsus about 380 µm long.

This species is named in honour of Dr Sándor Mahunka (Hungarian Natural History Museum, Budapest) acknowledging his willingness to allow us to study the material in his collection.

***Ortheziola matileferreroae* Kozár & Miller, sp.n.**  
(Fig. 13)

*Type material.* *Holotype*, female, TANZANIA: Poroto, elevation 2575 m, from litter of *Arundinaria alpina*, 22.i.1972 (T. Pócs) (number 160 from the collection of S. Mahunka). *Paratypes*, 10 females from the same collection. *Other material* (not paratypes), 3 females, TANZANIA: W.-Usambara, West montane rain forest, near Shumme sawmill 1960 m, 16.iii.1984 (T. Pócs) (no. 397 from the collection of S. Mahunka); 3 females MADAGASCAR: Andasibe, from forest soil, elevation 950–1000 m, 3.x.1994 (T. Pócs) (no. 9488); 5 females, MALAWI: Chambe Plateau, from forest soil, elevation 2010 m, 16.iv.1991 (T. Pócs) (no. 9185) (no. 660 from the collection of S. Mahunka). Deposited in the PPI, HNIM, USNM and BMNH.

*Unmounted adult female.* Marginal half of dorsum covered with white wax protrusions; with 3 distinct mediolateral wax

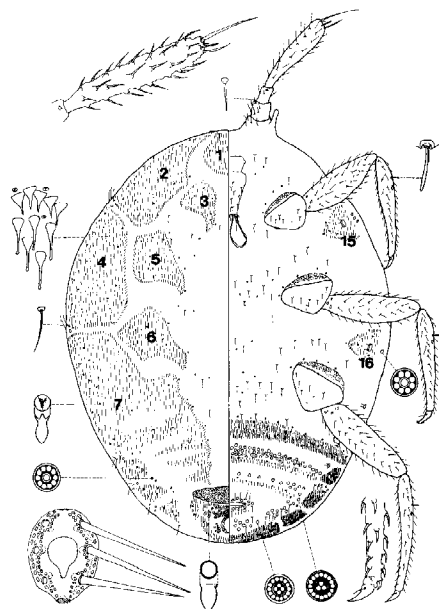


Fig. 13. *Ortheziola matileferreroae* sp.n.

protrusions on each side of body; broad band on midline of the dorsum bare, white (Fig. 17a). *Mounted adult female* (Fig. 13). Holotype 1.78 mm long (paratypes 1.40–1.74(1.54) mm); 1.58 mm wide (paratypes 1.13–1.40(1.21) mm). Sizes of antennal segments: 1st 115 µm long (paratypes 99–131(118) µm), 96 µm wide (paratypes 82–111(102) µm); 2nd 58 µm long (paratypes 77–96(87) µm), 51 µm wide (paratypes 52–57(55) µm); 3rd 390 µm long (paratypes 347–378(361) µm), 75 µm wide (paratypes 59–72(65) µm); with one sensory pore on the 2nd segment; 3rd segment nearly parallel sided; apical seta of antenna 224 µm long (paratypes 212–232(220) µm); subapical seta 70 µm long (paratypes 67–74(71) µm); flagellate sensory seta near apical seta 38 µm long (paratypes 32–37(35) µm); microseta near apex of antenna; unusual hair-like seta absent from near subapical seta; all segments of antennae covered with small number of robust, straight, apically acute setae, with longest seta 34 µm long (paratypes 40–44(42) µm); first antennal segment with one hair-like sensory seta on one side of segment; third antennal segment with 38 setae excluding apical ones (paratypes with 32–40(36) setae). *Venter*. Labium 154 µm long (paratypes 136–143(140) µm). Stylet loop shorter than labium. Legs with front coxa 154 µm long (paratypes 124–148(137) µm), middle 154 µm (paratypes 138–161(151) µm), hind 186 µm (paratypes 163–185(177) µm); front trochanter-femur 415 µm long (paratypes 372–403(385) µm), middle 432 µm (paratypes 391–

415(402) µm), hind 440 µm (paratypes 391–453(432) µm); front tibia-tarsus 432 µm (paratypes 384–453(429) µm), middle 456 µm (paratypes 431–465(450) µm), hind 548 µm (paratypes 499–546(530) µm); front claw 48 µm long (paratypes 49–57(53) µm), middle 46 µm (paratypes 52–59(55) µm), hind 54 µm (paratypes 54–62(58) µm); front claw digitules 14 µm long (paratypes 15–26(22) µm), middle 17 µm (paratypes 20–25(23) µm), hind 14 µm (paratypes 20–25(23) µm); legs with rows of robust setae, longest seta on trochanter-femur 26 µm long (paratypes 31–40(36) µm); with one flagellate sensory seta on tibia, 24 µm long (paratypes 25–35(32) µm); trochanter with 3 sensory pores on each surface (paratypes with 3 or 4). Wax plates present in marginal areas near thoracic spiracles only (plates 15 and 16); with marginal wax band surrounding each thoracic spiracle; without triangular-shaped wax plates in front of each coxa (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with one anterior band and one posterior row of spines within ovisac band. Thoracic spiracles with small clusters of multilocular pores laterad of each spiracular opening, each group containing 1–3, 8–10 locular pores, 6 µm in diameter (paratypes 4–5(5) µm); diameter of anterior thoracic spiracles 25 µm (paratypes 25–30(28) µm). Setae few, scattered in medial areas of thorax and around legs, with few setae near anterior edge of ovisac band (none are clavate), rare or absent from rows of multilocular pores, present near vulva. Multilocular pores with 13–16 loculi around perimeter, 3 or 4 loculi in central hub; 8 µm in diameter (paratypes 8–10(9) µm); present in 2 complete rows near anterior edges of spine bands, rows double or triple near anterior band, single near posterior band, pores scattered around vulva. Abdominal spiracles present with 2 pairs on each side of body anterior of ovisac band and one pair inside ovisac band near anterolateral angle; without sclerotized vestibule. *Dorsum*. Wax plates cover only marginal half of surface; mediolateral thoracic plates small (plates 3, 5 and 6), with large bare areas in mediolateral area; broad medial and submedial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4 14 µm long (paratypes 17–21(19) µm), in middle of wax plates about 20 µm long (paratypes 21–25(22) µm); spines apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 setae laterad of each thoracic spiracle, 22 µm long (paratypes 17–22(20) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8–13 loculi around perimeter, 1–3 loculi in central hub; 7 µm in diameter (paratypes 7–9(8) µm); present in marginal areas of abdomen; present in cluster near anal ring. Sclerotized plate 68 µm long (paratypes 73–84(79) µm), 288 µm wide (paratypes 279–285(271) µm); with 2 setae on posterior edge of plate with acute apices. Anal ring with incomplete double row of round pores (4 µm in diameter); longest seta broken (paratypes 42–62(51) µm); normally longer than length of anal ring; ring 52 µm wide (paratypes 59–65(60) µm), 66 µm long (paratypes 47–62(57) µm). Thumb-like pores about 6 µm long. Modified pores about 4 µm long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola matileferreroae* is similar in appearance with *O. jermyi*. For a comparison of these species see the comments section of the latter species. The specimens from the three last localities are not included in the type series because of the smaller number of multilocular pores and the presence of a wider marginal wax band on the venter around the thoracic spiracles. This species is named in honour of Danièle Matile Ferrero (Natural History Museum, Paris) acknowledging her help in our coccidological studies and her many important contributions to scale systematics.

***Ortheziola nelliae* Kozár & Miller, sp.n. (Fig. 14)**

**Type material.** *Holotype*, female, TANZANIA: Mkonda, submontane rainforest, elevation 900 m, 20.iii.1989 (S. Mahunka & A. Zicsi) (no. 739 from the collection of S. Mahunka). *Paratypes*, 5 females from the same collection. 5 females, TANZANIA: Mahezangulu, elevation 1000 m, 24.i.1985 (L. Peregovits) (no. 585 from the collection of S. Mahunka). Deposited in the PPI, HNHM, USNM and BMNH.

**Unmounted adult female.** Two-thirds of marginal area of dorsum covered with white, wax protrusions; with 4 distinct mediolateral wax protrusions on each side of body; narrow band on midline of the dorsum bare (Fig. 17d). **Mounted adult female** (Fig. 14). *Holotype* 2.20 mm long (paratypes 2.10–2.38(2.24) mm); 1.71 mm wide (paratypes 1.56–1.99(1.76) mm). Sizes of

antennal segments: 1st 144 µm long (paratypes 161–183(174) µm), 131 µm wide (paratypes 128–163(142) µm); 2nd 84 µm long (paratypes 94–118(110) µm), 64 µm wide (paratypes 69–86(76) µm); 3rd 606 µm long (paratypes 539–608(584) µm), 66 µm wide (paratypes 67–81(74) µm); 3rd segment parallel sided; apical seta of antenna broken (paratypes 168 µm), subapical seta 72 µm long (paratypes 68–69(68) µm); flagellate sensory seta near apical seta 34 µm long (paratypes 35–40(37) µm); microseta present near apex of antenna, unusual hair-like seta absent from near subapical seta; all segments of antennae covered with many hair-like, curved, apically capitate setae, longest seta 4 one µm long (paratypes 49–64(55) µm); first antennal segment with 2 hair-like sensory seta on each side of segment (paratypes with 1–3(2) setae); third antennal segment with 76 setae excluding apical ones (paratypes 69–82(75) setae). **Venter.** Labium 234 µm long (paratypes 222–251(242) µm). Stylet loop shorter than labium. Legs with front coxa 183 µm long (paratypes 173–220(198) µm), middle 221 µm (paratypes 212–232(224) µm), hind 217 µm (paratypes 223–254(242) µm); front trochanter-femur 647 µm long (paratypes 583–670(622) µm), middle 714 µm (paratypes 632–700(660) µm), hind 747 µm (paratypes 663–744(710) µm); front tibia-tarsus 730 µm long (paratypes 570–713(663) µm), middle 788 µm (paratypes 670–770(722) µm), hind 913 µm (paratypes 787–911(854) µm); front claw 64 µm long (paratypes 63–67(65) µm), middle 66 µm (paratypes 62–74(67) µm), hind 63 µm (paratypes 62–72(68) µm); front claw digitules 22 µm long (paratypes 22–30(25) µm), middle 20 µm (paratypes 26–28(27) µm), hind 22 µm (paratypes 22–30(27) µm); legs with rows of robust setae on tibia, with hair-like setae on femur; longest on trochanter-femur 43 µm long (paratypes 37–52(45) µm); with one flagellate sensory seta on tibia 28 µm long (paratypes 27–44(35) µm); trochanter sensory pores impossible to see (paratypes with 4 pores). Wax plates present in marginal areas of head and thorax, with wide marginal wax plate laterad of each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of each coxa (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; with one anterior band and one posterior row of spines within ovisac. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 17–20 (paratypes 15–20(18) µm), 8 locular pores (paratypes with 8 or 9 loculi), 7 µm in diameter (several of these pores on dorsum); diameter of anterior thoracic spiracles 38 µm (paratypes 37–40(38) µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some setae clavate) and associated with both bands of multilocular pores, also associated with multilocular pores around vulva. Multilocular pores with 14 loculi around perimeter (paratypes 13 or 14 loculi), 3 loculi in central hub (paratypes 3–5 loculi); 11 µm in diameter (paratypes 10–11(10) µm); present in 2 complete rows near anterior edges of spine bands, scattered around vulva. Modified pores scattered over surface. Abdominal spiracles present with 2 pairs on each side of body anterior of ovisac band and one pair inside ovisac band near anterolateral angle; with sclerotized vestibule. **Dorsum.** Wax plates are marginal and cover two-thirds of surface; mediolateral thoracic plates small (plates 3, 5 and 6), leaving conspicuous mediolateral thoracic

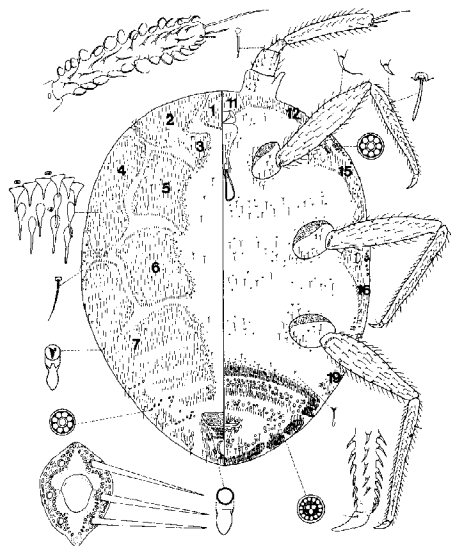


Fig. 14. *Ortheziola nelliae* sp.n.

areas; plate 3 usually fused with plate 2; narrow medial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4  $14\text{ }\mu\text{m}$  long (paratypes 15–20(17)  $\mu\text{m}$ ), in middle of wax plates about  $18\text{ }\mu\text{m}$  long (paratypes 21–24(22)  $\mu\text{m}$ ); spines not apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3–5 setae laterad of each thoracic spiracle,  $29\text{ }\mu\text{m}$  long (paratypes 32–43(39)  $\mu\text{m}$ ); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8 or 9 loculi around perimeter, one loculus in central hub;  $8\text{ }\mu\text{m}$  in diameter (paratypes 6–7(6)  $\mu\text{m}$ ); present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate  $128\text{ }\mu\text{m}$  long (paratypes 107–131(120)  $\mu\text{m}$ ),  $313\text{ }\mu\text{m}$  wide (paratypes 316–366(340)  $\mu\text{m}$ ); with 2 setae near posterior edge of plate. Anal ring with incomplete double row of round pores ( $4\text{ }\mu\text{m}$  in diameter); longest seta broken (paratypes 52–84(69)  $\mu\text{m}$ ); longer or shorter than length of anal ring; ring  $60\text{ }\mu\text{m}$  wide (paratypes 59–67(63)  $\mu\text{m}$ ),  $68\text{ }\mu\text{m}$  long (paratypes 79–88(84)  $\mu\text{m}$ ). Thumb-like pores  $8\text{ }\mu\text{m}$  long (paratypes 9–12(10)  $\mu\text{m}$ ). Modified pores  $6\text{ }\mu\text{m}$  long (paratypes 5–7(6)  $\mu\text{m}$ ). Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola nelliae* is similar to *O. giliomeei*. For a comparison of these species see the comments section of the latter species.

This species is named in honour of the first author's daughter Kornélia Kozár acknowledging her help in scale insect collecting. Nelli is a nickname of Kornélia.

### *Ortheziola vej dovskiyi* Šulc, 1895 (Fig. 15)

*Orthezia signoreti* (Haller, 1880: 6) (junior homonym of *Orthezia signoreti* White, 1877).

*Orthezia vej dovskiyi* Šulc, 1895: 1.

There has been considerable confusion about the correct name of this species. In the revisions by Morrison (1925, 1952) the name *Ortheziola signoreti* (Haller) (described in the genus *Orthezia*) was used. Varshney (1964) realized that the latter name was a junior primary homonym of *Orthezia signoreti* White, now considered to be a junior synonym *Arctorthezia cataphracta* (Olafsen) and revived the next available synonym *Ortheziola vej dovskiyi*.

**Type material.** We have searched for type material of this species in several museums in Europe without success. Neither Prof. J. Zahradnik, Prague, Czech Republic, nor Dr Z. Sustek, Bratislava, Slovakia, know of the whereabouts of the Šulc collection. Recently, Douglas J. Williams discovered dry material sent by Šulc to Green in the BMNH. Although there is no date, it presumably is part of the type series. From these syntypes we have selected as lectotype an adult female mounted alone on a slide with the label: 'Ortheziola vej dovskiyi Šulc/Králové Dvůr/under moss/K. Šulc.' A second label has been added 'Ortheziola vej dovskiyi Šulc/LECTOTYPE/designated by/Kozár and Miller'. There are four paralectotype slides each containing one adult female and two unmounted paralectotypes. All are deposited in the BMNH.

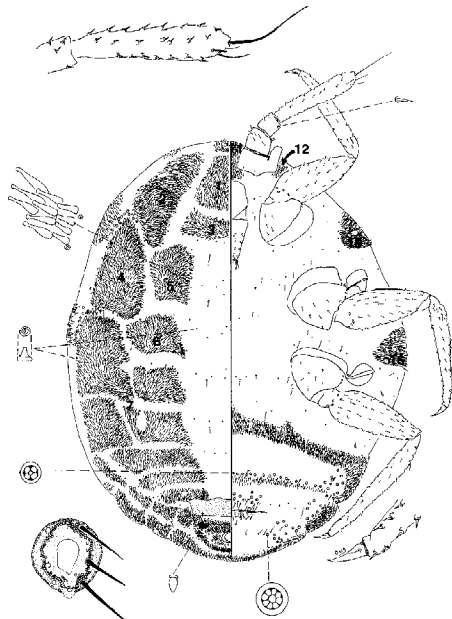


Fig. 15. *Ortheziola vej dovskiyi* Šulc.

**Material examined.** One female, BELGIUM: Putt-lez-Malines, taken in quarantine at Washington, D.C., on rose bush, 16.vi.1922 (R. D. Kennedy); one female, FRANCE: in quarantine at Hoboken, New Jersey, on woods moss, 7.xii.1948 (R. Albright); 2 females, GERMANY: quarantine at Washington, D.C., on rose bush, 17.i.1933 (W. I. Wharton); UNITED KINGDOM: 4 females, ENGLAND: in quarantine at New York, in soil with holly roots, 17.xii.1935 (F. O. Dodd); 6 females, WALES: Llangam-march, Breconshire, under moss, v. 1925 (E. E. Green); one female, HUNGARY: Budapest, Sashegy, on soil surface with *Sesleria sadleriana*, 18.x.1996 (F. Samu). Deposited in the USNM and PPI. **Other material.** According to Kosztarab & Kozár (1988) this species is also reported from AUSTRIA, CZECHOSLOVAKIA, ITALY, LUXEMBOURG, MADEIRA ISLANDS, POLAND, ROMANIA, FORMER SOVIET UNION, SWITZERLAND and YUGOSLAVIA. It also is known from SWEDEN (Ossiannilsson, 1984).

**Unmounted adult female.** Two-thirds of dorsum covered with white, wax protrusions; with 5 or 6 mediolateral wax protrusions on each side of body; band on midline of dorsum bare, yellowish. **Mounted adult female** (Fig. 15). 1.61–1.83(1.74) mm long; 1.22–1.40(1.33) mm wide. Size of antennal segments: 1st 84–113(95)  $\mu\text{m}$  long, 57–90(77)  $\mu\text{m}$  wide; 2nd 69–84(75)  $\mu\text{m}$  long (Hungarian material 62  $\mu\text{m}$ ), 44–57(50)  $\mu\text{m}$

wide; 3rd 309–346(327)  $\mu\text{m}$  long, 49–62(56)  $\mu\text{m}$  wide; 3rd segment parallel sided; apical seta of antenna 158–163(161)  $\mu\text{m}$  long (Hungarian material 154  $\mu\text{m}$ ), subapical seta 52–59(56)  $\mu\text{m}$  long (Hungarian material 51  $\mu\text{m}$ ); flagellate sensory seta near apical seta 30–48(34)  $\mu\text{m}$  long; microseta present near apex of antenna; unusual hair-like seta absent from near subapical seta; all segments of antennae covered with moderate number of spine-like, straight, apically acute setae, longest seta 12–16(14)  $\mu\text{m}$  long; first antennal segment with 2 capitate sensory setae on each side of segment; third antennal segment with 35–45(40) setae excluding those near apex. *Venter*. Labium 148–173(157)  $\mu\text{m}$  long. Stylet loop about as long as labium. Legs with front coxa 150–167(157)  $\mu\text{m}$  long, middle 155–167(161)  $\mu\text{m}$ , hind 161–180(172)  $\mu\text{m}$ ; front trochanter-femur 366–391(379)  $\mu\text{m}$  long (Hungarian material 398  $\mu\text{m}$ ), middle 372–403(392)  $\mu\text{m}$  (Hungarian material 407  $\mu\text{m}$ ), hind 409–440(428)  $\mu\text{m}$ ; front tibia-tarsus 403–422(414)  $\mu\text{m}$  long, middle 428–453(441)  $\mu\text{m}$ , hind 496–539(522)  $\mu\text{m}$ ; front claw 62–64(63)  $\mu\text{m}$  long (Hungarian material 55  $\mu\text{m}$ ), middle 51–62(59)  $\mu\text{m}$ , hind 49–72(63)  $\mu\text{m}$ ; front claw digitules 15–16(16)  $\mu\text{m}$  long, middle 12–19(16)  $\mu\text{m}$ , hind 12–22(16)  $\mu\text{m}$ ; legs with rows of robust setae; longest on trochanter-femur 12–15(14)  $\mu\text{m}$  long; with one flagellate sensory seta on tibia, 15–23(19)  $\mu\text{m}$  long; trochanter with 4 sensory pores on each surface. Wax plates absent from marginal areas of head and thorax except for small spine cluster laterad of antenna (plate 12) and normal plate between antennae (plate 11), with marginal wax band surrounding each thoracic spiracle (plates 15 and 16); without triangular-shaped wax plates in front of coxae (plates 13, 17 and 18); without cluster of spines between hind legs and ovisac band; without remnants of plate 19 near body margin; with one band of spines within ovisac band. Thoracic spiracles with scattered quadricular pores loosely associated with each spiracular opening, each group containing 0–15(7) pores, 5–6(5)  $\mu\text{m}$  in diameter (several of these pores on dorsum) (Hungarian material 7  $\mu\text{m}$ ); diameter of anterior thoracic spiracles 20–24(22)  $\mu\text{m}$ . Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band (some are capitate), several associated with anterior and posterior multilocular rows, several more associated with posterior multilocular pores surrounding vulva. Multilocular pores with 4–9 loculi around perimeter, one loculus in central hub; 5–8(6)  $\mu\text{m}$  in diameter (Hungarian material 10  $\mu\text{m}$ ); with quadricular pores predominant near anterior edge of spine band, partial row of multiloculars near anterolateral edge of spine band, also scattered around vulva and near ovisac band. Abdominal spiracles present with 2 pairs on each side of body anterior of ovisac band and one pair inside ovisac band near anterolateral angle; with sclerotized vestibule. *Dorsum*. Wax plates cover two-thirds of marginal area of surface; mediolateral thoracic plates small (plates 3, 5 and 6), covering most of mediolateral thoracic areas; medial area of thorax and abdomen without spines and pores; plate 3 not divided medially. Spines at margin of wax plate 4 12–17(16)  $\mu\text{m}$  long, in middle of wax plates 17–19(18)  $\mu\text{m}$  long; spines not apically capitate. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 2–5(4) setae laterad of each thoracic spiracle, 16–24(22)  $\mu\text{m}$  long; also present in very small

numbers on other wax plates and in medial bare area. Multilocular pores with 4 loculi around perimeter, one loculus in central hub; 5–7(6)  $\mu\text{m}$  in diameter; present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 47–74(64)  $\mu\text{m}$  long, 269–291(282)  $\mu\text{m}$  wide; without setae at posterior edge of plate. Anal ring with incomplete triple row of round pores (2–3  $\mu\text{m}$  in diameter); longest seta 42–62(55)  $\mu\text{m}$  long; longer than length of anal ring; ring 54–64(58)  $\mu\text{m}$  wide (Hungarian material 53  $\mu\text{m}$ ), 52–67(59)  $\mu\text{m}$  long. Thumb-like pores 5–6(5)  $\mu\text{m}$  long (Hungarian material 7  $\mu\text{m}$ ). Modified pores 6(5–7)  $\mu\text{m}$  long. Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

*Comments.* *Ortheziola vej dovskyi* is similar to *O. britannica*. For a comparison of these species see the comments section of the latter species.

***Ortheziola williamsi* Kozár & Miller, sp.n. (Fig. 16)**

*Type material.* *Holotype*, female, TANZANIA: Uluguru, Kimbora, from litter of karstic tropical forest, 9.vii.1972 (T. Pócs) (no. 169 from the collection of S. Mahunka). *Paratypes*, 5 females from the same collection. *Other material* (not paratypes). 5 females, TANZANIA: Uluguru, elevation 1700 m, from litter, 9.x.1971 (T. Pócs) (no. 86 from the collection of S. Mahunka); one female, TANZANIA: Kilimanjaro, Mweka, elevation 2550–2650 m, from moss of

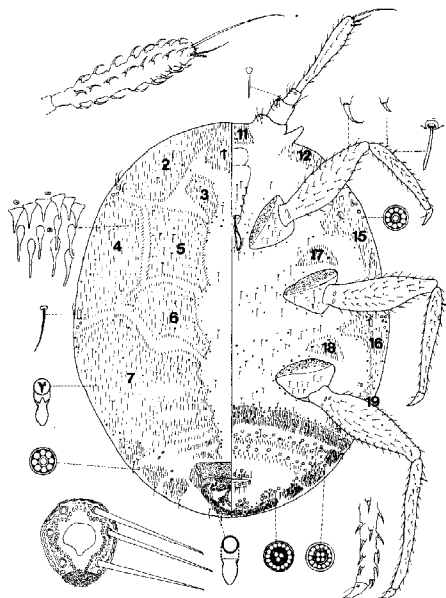


Fig. 16. *Ortheziola williamsi* sp.n.

*Erica arborea* forest, 29.vii.1972 (T. Pócs) (no. 109 from the collection of S. Mahunka). Deposited in the PPI, HHNM, USNM and BMNH.

**Unmounted adult female.** Two-thirds of dorsum covered with white, wax protrusions; with 4 distinct mediolateral wax protrusions on each side of body; band on midline of the dorsum bare (Fig. 17b). **Mounted adult female** (Fig. 16). Holotype 1.08 mm long (paratypes 1.18–1.35(1.25) mm); 0.87 mm wide (paratypes 1.07–1.20(1.14) mm). Sizes of antennal segments: 1st 94 µm long (paratypes 91–96(94) µm), 64 µm wide (paratypes 64–82(73) µm); 2nd 55 µm long (paratypes 59–67(63) µm), 32 µm wide (paratypes 37–40(38) µm); 3rd 234 µm long (paratypes 237–249(243) µm), 40 µm wide (paratypes 44–47(46) µm); 3rd segment nearly parallel sided; apical seta of antenna 141 µm long (paratypes 101 µm), subapical seta 38 µm long (paratypes 32–46(39) µm); flagellate sensory seta near apical seta 22 µm long (paratypes 20–26(23) µm); microseta present near apex of antenna; unusual hair-like seta absent from near subapical seta; all segments of antennae covered with moderate number of robust, curved, apically acute setae, longest seta 20 µm long (paratypes 25–27(26) µm); first antennal segment with one hair-like sensory seta on each side of segment; third antennal segment with 32 setae (paratypes with 25–36(30) setae). **Venter.** Labium 120 µm long (paratypes 128–131(130) µm). Stylet loop shorter than labium. Legs with front coxa 120 µm long (paratypes 104–111(108) µm), middle 138 µm (paratypes 126–131(128) µm), hind 144 µm (paratypes 128–145(136) µm); front trochanter-femur 304 µm (paratypes 304–310(307) µm), middle 320 µm (paratypes 322–329(326) µm), hind 373 µm (paratypes 366–372(369) µm); front tibia-tarsus 272 µm long (paratypes 298–310(304) µm), middle 320 µm (paratypes 316–322(319) µm), hind 382 µm (paratypes 378–384(381) µm); front claw 32 µm long (paratypes 38–40(39) µm), middle 38 µm (paratypes 37–40(38) µm), hind 41 µm (paratypes 43–44(44) µm); front claw digitules 8 µm long (paratypes 14–15(14) µm), middle 7 µm (paratypes 15 µm), hind broken (paratypes 17–20(18) µm); legs with rows of robust setae; longest on hind trochanter-femur 22 µm long (paratypes 30–32(31) µm); with one flagellate sensory seta on tibia, 13 µm long (paratypes 17–20(18) µm); trochanter with 3 sensory pores on each surface (paratypes with 1–3). Wax plates present in marginal areas of head and thorax, with wide marginal wax band laterad of each thoracic spiracle (plates 15 and 16); with triangular-shaped wax plates in front of hind 2 pairs of coxae (plates 17 and 18), absent from near front coxae (plate 13); without cluster of spines between hind legs and ovisac band; with 2 bands of spines within ovisac band. Thoracic spiracles with clusters of multilocular pores laterad of each spiracular opening, each group containing 2–7, 8–10 locular pores, 7 µm in diameter (paratypes 6–7(6) µm) (several of these pores on dorsum); diameter of anterior thoracic spiracles 23 µm (paratypes 22–23(22) µm). Setae few, scattered in medial areas of thorax, with several setae near anterior edge of ovisac band, several associated with anterior multilocular row, none associated with second row, several more associated with

posterior multilocular pores, a few setae in ovisac band clavate. Multilocular pores with 12–16 loculi around perimeter, 3 or 4 loculi in central hub; 7 µm in diameter (paratypes 7–10(9) µm); present in 2 complete rows near anterior edges of spine bands, row near anterior band double, row near posterior band single, scattered around vulva. Abdominal spiracles present near anterolateral angle of ovisac band; vestibule of spiracle without sclerotization. **Dorsum.** Wax plates cover two-thirds of marginal area of surface; mediolateral thoracic plates large, covering most of mediolateral thoracic areas (plates 3, 5 and 6); medial area of thorax and abdomen without spines and pores. Spines at margin of wax plate 4 10 µm long (paratypes 12–14(13) µm), in middle of wax plates about 16 µm long (paratypes 21–22(22) µm); spines without capitate apex. Setae present in marginal clusters near posterior edges of marginal wax plates (plates 2 and 4), with 3 or 4 setae laterad of each thoracic spiracle (paratypes with 4–5(4) setae), 14 µm long (paratypes 17–20(18) µm); also present in very small numbers on other wax plates and in medial bare area. Multilocular pores with 8–10 loculi around perimeter, one loculus in central hub; 7 µm in diameter;

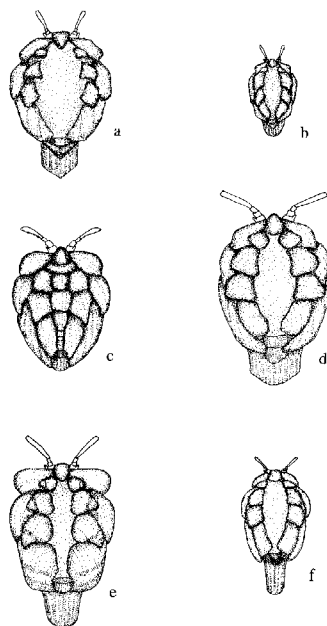


Fig. 17. Wax covering of some *Ortheziola* females: a, *O. matileferreroae*; b, *O. williamsi*; c, *O. guineensis*; d, *O. nelliae*; e, *O. mahunkai*; f, *O. giliomeei*.

present in marginal areas of abdomen; also present in cluster near anal ring. Sclerotized plate 58 µm long (paratypes 72–79(74) µm), 218 µm wide (paratypes 220–240(250) µm); with 2 setae on posterior edge of plate. Anal ring with incomplete double row of round pores (2 µm in diameter); longest anal ring seta broken (paratypes 47–49(48) µm); longer than length of anal ring; ring 41 µm wide (paratypes 40–49(44) µm), 48 µm long (paratypes 42 µm). Thumb-like pores 6 µm long (paratypes 4–6(5) µm). Modified pores 5 µm long (paratypes 4 µm). Abdominal spiracle in centre of multilocular cluster laterad of anal ring.

**Comments.** *Ortheziola williamsi* is similar in appearance to *O. benedictiae*, *O. mahunkai* and *O. fercsii*. For comparisons of these species see the comments sections of the latter three species.

The specimens from the last localities are not included in the type series because of differences in the number of multilocular pores, the shape of the setae on the antenna and the smaller number of wax plates.

This species is named in honour of Dr Douglas J. Williams (United Kingdom), acknowledging his important assistance in our coccidological studies and his many important contributions to scale insect systematics.

## Soil samples

Of the 1411 African soil samples examined, only eighty-four contained specimens of *Ortheziola*. Samples were found to contain species of *Ortheziola* from nine African countries of the total of nineteen that were examined. Of the African species, only *O. ankazobensis*, *O. guineensis*, *O. mahunkai* and *O. kosztarabi* occur outside of the eastern part of the continent. There is a paucity of species from both northern and southern Africa. The highest number (seven species) of *Ortheziola* was recorded in Tanzania; in Madagascar three species are known; in South Africa there are two; in all other countries only one species is reported. Species that were most commonly collected in the samples were *O. jermyni* (in ten samples), *O. benedictiae* (in eight samples) and *O. giliomeei* (in seven samples). It also is worth noting that of the eighty-four samples that contained specimens of *Ortheziola*, only one included more than one species (two). On the other hand, it was more common to find two (in seven samples) or even three different genera (in one sample) in a single sample. These data suggest the possibility that *Ortheziola* species have divided resources in a localized geographical manner, whereas different ortheziid genera have divided resources more finely within a particular habitat. No *Ortheziola* specimens were found in samples examined outside of Africa. From the Nearctic six samples were studied, from the Neotropical 361, Australia and New Zealand thirty-four, Oriental 311 and from the Palearctic five samples were studied. The 1411 African samples studied contained adult female specimens of the following ortheziid genera: *Ortheziola* 125, *Neusteadia* sixty-four, *Nipponorthezia* thirty-one and *Orthezia* one. For a map of the general distribution of *Ortheziola* species see Fig. 18.

## Phylogenetic analyses

Results of the analyses using *Orthezia urticae* alone or *O. urticae*, *Mixorthezia reynei* and *Nipponorthezia guadalcanalia* in combination as the outgroup produced four most parsimonious cladograms (length = 93, CI = 0.50, RI = 0.65). Differences in the four cladograms reflect minor rearrangements in the positions of *Ortheziola matileferroae*, *O. ethiopiensis* and *O. jermyni*; we have used the first cladogram for the purposes of discussion (Fig. 19). We will refer to this as hypothesis 1 with *O. kosztarabi*, *O. loebli* and *O. guineensis* located basally and *O. britannica* and *O. vej dovskiyi* located apically. The same four most parsimonious cladograms were produced when *M. reynei* alone or *M. reynei* and *N. guadalcanalia* together were used as outgroup. There are seventeen character states supporting the monophyly of *Ortheziola* (five are homoplasious). The most obvious characters are the unique coalesced arrangements of the wax plates, the hair-like claw digitules, the triplex setae on the labium, the thumb-like pores near the anal ring, the abdominal spiracle that resides in a cluster of multilocular pores laterad of the anal ring and the abdominal spiracle that is present inside the anterolateral angle of the ovisac band. The unusual sclerotized plate and bizarre false basal segment of the antenna are not unique to *Ortheziola* but are shared with *Mixorthezia*. These characters must be given a weight of three times that of the remaining characters to place *Mixorthezia* as the sister of *Ortheziola* rather than *Nipponorthezia*. When running a decay analysis (Bremer, 1994), there were seventy-one cladograms with one extra step (length = 94) and the strict consensus cladogram is a bush within *Ortheziola* except the clade containing *O. loebli* and *O. kosztarabi*. The decay analysis using majority rule consensus cladogram gave one additional resolved clade containing *O. benedictiae* and *O. fercsii*. When running a decay analysis with three and four extra steps there were 9534 cladograms and more than 32 000 cladograms, respectively, and the structure of the strict consensus cladogram and the majority rule consensus cladogram were identical containing the *Ortheziola* clade and the *O. loebli* and *O. kosztarabi* lineage. We suspect that the lineage defining the *Ortheziola* clade would not deteriorate for several more iterations and is well supported. Lack of resolution within the *Ortheziola* clade in the decay analysis suggests that there is weak support for most groups in *Ortheziola*.

A second analysis was run using *N. guadalcanalia* as the sole outgroup. Results gave thirty-two most parsimonious cladograms (length = 73, CI = 0.52, RI = 0.61). Surprisingly, twenty of the cladograms are arranged almost exactly in reverse of hypothesis 1 with *O. kosztarabi*, *O. loebli* and *O. guineensis* in an apical position and *O. vej dovskiyi* and *O. britannica* placed basally. We will call this topology, hypothesis 2. The first of the twenty cladograms (no. 14) is shown in Fig. 20 as an example. The remaining twelve cladograms conform to hypothesis 1. When a successively weighted analysis is run, six most parsimonious cladograms are produced that conform to hypothesis one only. The strict consensus of these is a bush except for a clade containing *O. kosztarabi*, *O. loebli* and *O. guineensis* and another containing *O. fercsii* and *O. benedictiae*. These clades are identical with those obtained in



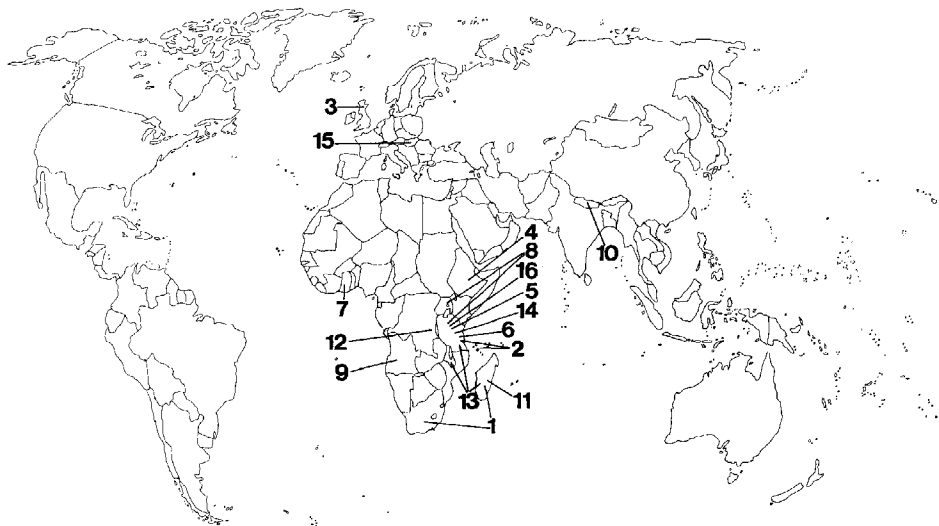


Fig. 18. Country distribution of *Ortheziola* species (1, *O. ankazobeensis*; 2, *O. benedictyae*; 3, *O. britannica*; 4, *O. ethiopiensis*; 5, *O. fercsii*; 6, *O. giliomeei*; 7, *O. guineensis*; 8, *O. jermyi*; 9, *O. kosztarabi*; 10, *O. loebli*; 11, *O. madecassa*; 12, *O. mahunkai*; 13, *O. matileferreroae*; 14, *O. nelliae*; 15, *O. vej dovskiyi*; 16., *O. williamsi*).

the first analysis. The majority rule consensus cladogram is similar to Fig. 20 and hypothesis 2. The decay analysis allowing one and two extra steps (74 and 75) produced 641 and 7172 cladograms and the majority rule and strict consensus of these are identical, containing only a single resolved clade containing *O. guineensis*, *O. kosztarabi* and *O. loebli*.

These results suggest that the internal structure of the cladogram is influenced by the choice of outgroup, but additional evidence shows that exclusion of certain taxa in the ingroup also influences this structure. To visualize this influence Table 1 was devised containing several combinations of taxa and outgroup. While examining Table 1 it is important to remember that hypothesis 1 has the *vej dovskiyi*-*britannica* lineage and its close relatives such as *O. madecassa* in an apical position and the *kosztarabi*-*loebli*-*guineensis* lineage and its relatives such as *O. mahunkai* in a basal position. Hypothesis 2 is just the opposite.

We also investigated the possibility that removal of lineages other than the *vej dovskiyi*-*britannica* and the *kosztarabi*-*loebli*-*guineensis* would effect cladogram structure. When *Orthezia urticae* was used as the outgroup, removal of each species individually did not alter the structure of the majority rule consensus cladogram. There were variations in the number of most parsimonious cladograms, CI and RI, but the basic structure remained the same and was consistent with hypothesis 1. Removal of the *benedictyae*-*ferscii* lineage also did not alter the hypothesis 1 topology nor did sampled combinations of two or three taxa that are placed in the near vicinity of one

another in Fig. 19. No taxon-removal scenarios other than removal of the *kosztarabi*-*loebli*-*guineensis* lineage caused the cladogram structure to become altered to hypothesis 2 or altered into any other significantly different structure.

When *Nipponorthesia guadalcanalia* was used as the outgroup without *Orthezia urticae* and *Mixorthesia reynei*, removal of species individually had little effect on the majority consensus cladogram structure and was consistent with hypothesis 2. Removal of sampled combinations of two or three taxa that are placed in the near vicinity of one another in Fig. 19 did not alter the hypothesis 2 topology. Removal of the *O. vej dovskiyi* produced a near bush when examining the majority consensus cladogram. No taxon-removal scenarios other than removal of the *vej dovskiyi*-*britannica* lineage caused the cladogram to become altered to the hypothesis 1 structure or to any other significantly different structure.

These results show that removal of only the *kosztarabi*-*loebli*-*guineensis* lineage when *O. urticae* is the outgroup causes the cladogram structure to reverse itself from hypothesis 1 to hypothesis 2 topology. These results also demonstrate that removal of only the *vej dovskiyi*-*britannica* lineage when *N. guadalcanalia* is the outgroup causes the hypothesis 2 to take on hypothesis 1 topology.

We also examined the effect of removing characters to see if character deletion would effect topology in the same way as altered outgroup choice and taxon removal scenarios. We found that there was an effect. When *O. urticae* is the outgroup, removal of two characters at a time that have derived character

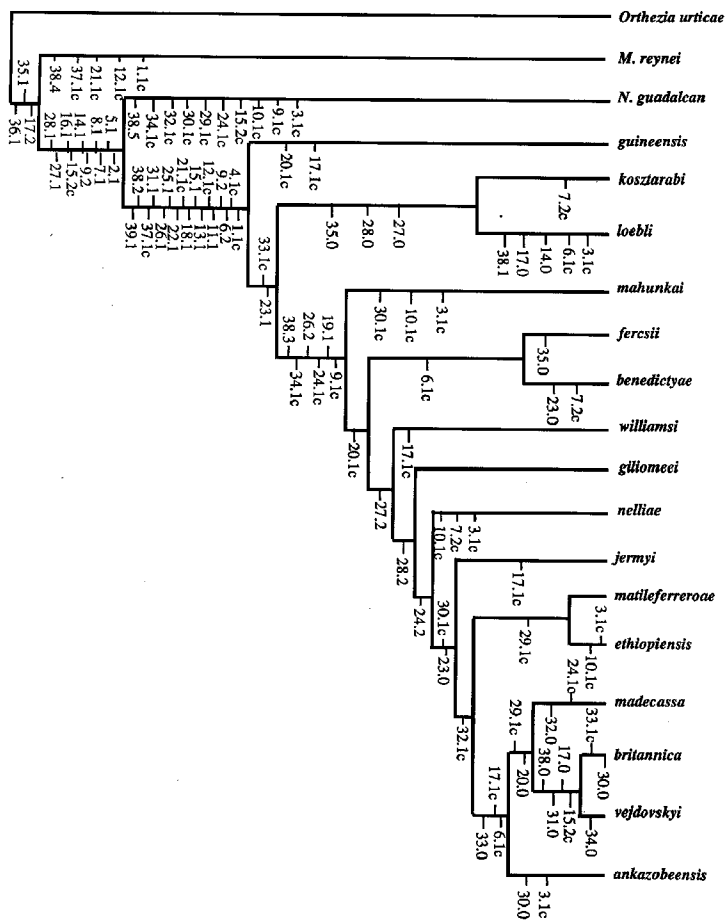


Fig. 19. Cladogram number 1 of four most parsimonious cladograms showing relationships of *Orthezia* species (length = 93, CI = 0.50, RI = 0.65) with *Orthezia urticae* as the outgroup. Hypothesis number 1.

states in *vej dovskiyi-britannica* and primitive states in *kosztarabi-loebli-guineensis* alter the structure from hypothesis 1 topology to hypothesis 2. The characters that have this polarity are 19, 24, 27, 28, 29 and 32. When *Nipponorthezia guadalcanalia* was used as the outgroup without *Orthezia urticae* and *Mixorthezia reynei*, structure was changed from hypothesis 2 to hypothesis 1 with the removal of any single character with primitive character states in *vej dovskiyi-britannica* and derived states in *kosztarabi-loebli-guineensis*. Characters that have this condition are 15, 23, 29, 31, 32 and 33.

Careful examination demonstrates that each scenario (outgroup alteration, taxon deletion and character deletion) has the same basic effect, i.e. they eliminate or change the efficacy of one or more characters in either the *vej dovskiyi-britannica* or *kosztarabi-loebli-guineensis* clades. Change of the outgroup from *Orthezia urticae* to *Nipponorthezia guadalcanalia* changes the polarity in enough characters to cause the overall structure of the cladogram to reverse from hypothesis 1 to 2. Characters important in this transformation are 9, 15, 32, 34 and 35. For example, in character 32 with *O. urticae* as the outgroup *vej dovskiyi-britannica* is scored 1 and *kosztarabi-*

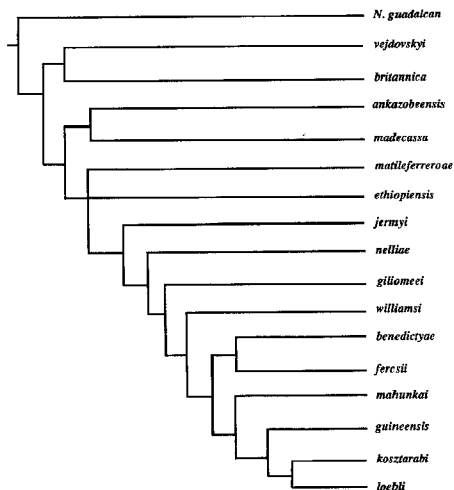


Fig. 20. Cladogram number 14 of 32 most parsimonious cladograms showing relationships of *Ortheziola* species (length = 73, CI = 0.52, RI = 0.61) with *Nipponorthezia guadalcanalia* as the outgroup. Hypothesis number 2.

*loebli-guineensis* is scored 0 but when *N. guadalcanalia* is the outgroup *vej dovskiyi-britannica* is scored 0 and *kosztarabi-loebli-guineensis* is scored 1. The polarity change in these five characters is significant enough to reverse the structure from the hypothesis 1 topology to 2. Under the taxon-deletion scenario only removal of the basal lineage comprised of either *kosztarabi-loebli-guineensis* in hypothesis 1 or *vej dovskiyi-britannica* in hypothesis 2 causes a significant change in topology. When *kosztarabi-loebli-guineensis* is removed with *O. urticae* as the outgroup (hypothesis 1), characters 19, 24, 34 and 35, which each have apomorphic character states for *vej dovskiyi-britannica* and plesiomorphic states for *kosztarabi-loebli-guineensis*, all become uninformative within the *Ortheziola* clade and have a significant enough effect to place *vej dovskiyi-britannica* basally. When *vej dovskiyi-britannica* is removed with *N. guadalcanalia* as the sole outgroup (hypothesis 2), characters 15 and 31, which each have plesiomorphic character states in *vej dovskiyi-britannica* and apomorphic states for *kosztarabi-loebli-guineensis*, become uninformative and have significant enough effect to place *kosztarabi-loebli-guineensis* basally. Under the character-deletion scenario the elimination of one or more selected characters is sufficient to alter cladogram topology from hypothesis 1 to hypothesis 2 or vice versa.

## Discussion

*Ortheziola* is much more diverse than previously surmised. It currently contains sixteen species, and it is reasonable to assume

that many more await discovery, particularly in the mountainous areas of east Africa and possibly Asia. It is interesting that only two species are known from the Palearctic (*O. vej dovskiyi* and *O. britannica*) and only one other species is reported from outside of Africa (*O. loebli*). Even within Africa, only four of the thirteen Afrotropical species are reported outside of the eastern region (Fig. 18), i.e. *O. ankazobeensis*, *O. guineensis*, *O. mahunkai* and *O. kosztarabi*, even though Berlese funnels were used to sample most areas of the continent. It appears that the genus prefers montane habitats where there is an accumulation of soil litter and moss.

Results of the phylogenetic analyses give strong support for the monophyly of *Ortheziola*. Bremer analysis and the large number of synapomorphies give evidence of a well defined *Ortheziola* group. The relationships of the species within the genus are not so clear. It appears that *O. vej dovskiyi* and *O. britannica* form a well delineated group and the same is true for *O. kosztarabi* and *O. loebli*. There is weaker evidence supporting clades composed of *kosztarabi-loebli-guineensis* and *benedictyae-fersii*. The relationships of the other taxa are not clear except that *O. ankazobeensis* and *O. madeassae* are placed close to *vej dovskiyi-britannica* and *O. mahunkai* is placed near *kosztarabi-loebli-guineensis*. The placement of *vej dovskiyi-britannica* and *kosztarabi-loebli-guineensis* is problematic. The data suggest two evolutionary hypotheses. The best supported hypothesis (Fig. 19, hypothesis 1) places *O. kosztarabi*, *O. loebli* and *O. guineensis* as basal taxa with *O. vej dovskiyi* and *O. britannica* placed apically. This hypothesis is logical in many ways since there is a general trend toward reduction in the more derived species, a process that has permeated the evolutionary history of Coccoidea. Although *O. vej dovskiyi* and *O. britannica* possess several reductions, they also have a series of character states that are unlike those of any other species in the genus and some of which are shared with the outgroups. Examination of distribution data demonstrates congruence throughout most of the cladogram with the exception of *O. vej dovskiyi* and *O. britannica*. It appears that ancestral forms occurred in west Africa and radiated northward into Asia and eastward into east Africa. The part of this hypothesis that seems unlikely is that *O. vej dovskiyi* and *O. britannica* as Palearctic species evolved from the most advanced elements of east Africa and somehow managed to inhabit Europe in presumably relatively recent times. Hypothesis 2 (Fig. 20) is not as strongly supported by the data and is inconsistent with the overall tendency of simplification in scale insects. It does, however, allow a more believable scenario for the distribution and unique morphological characteristics demonstrated by *O. vej dovskiyi* and *O. britannica*. Using this scenario, these species are basal and have had time to evolve a quite different morphological appearance in isolation from their Asian and African counterparts.

It is interesting that outgroup choice, taxon deletion and character deletion each cause changes in cladogram topology. It is important to note that these changes take only one of two basic forms (hypotheses 1 and 2). Evidence strongly suggests that the *vej dovskiyi-britannica* and *kosztarabi-loebli-guineensis* lineages are the key to understanding these changes. The evidence is: (1) only

**Table 1.** Cladogram statistics for analyses using different outgroups and different combinations of excluded taxa. Abbreviations are: urticae = *Orthezia urticae*; vej = *Ortheziola vejovskyi*; brit = *O. britannica*; kos = *O. kosztarabi*; loe = *O. loebli*; gui = *O. guineensis*; guad = *Nipponorthezia guadalcanalis*.

Outgroup/ excluded taxa	No. trees	Tree length	CI	RI	Predominant hypothesis	Majority rule consensus hypothesis	Successive weighting hypothesis
urticae/none	4	93	0.50	0.65	1	1	1
urticae/vej-brit	1	86	0.54	0.66	1	—	—
urticae/kos-loe-gui	21	78	0.56	0.67	2	2	1
guad/urt-rey	32	73	0.52	0.61	2	2	1
guad/urt-rey-vej-brit	3	66	0.58	0.60	1	1	1
guad/urt-rey-kos-loe-gui	18	56	0.57	0.61	2	2	2

removal of the taxa in these lineages causes significantly different cladogram topologies; (2) reversal of cladogram topology occurs only where changes in outgroup choice have a major impact on the polarity of characters that effect taxa in these lineages; (3) reversal of cladogram topology occurs only when character deletions have a significant impact on the polarity of characters in these lineages.

The evolutionary significance of this is not readily apparent. Certainly, hypotheses 1 and 2 have sufficient support to be investigated more fully. But perhaps a third hypothesis should be explored also. When both the *vejovskyi-britannica* and *kosztarabi-loebli-guineensis* lineages are included in the analysis they have a significant impact on the position of the other. When one is removed from the analysis the other takes a basal position on the cladogram; each seems to have a natural tendency to be basal. Perhaps these groups are so different in appearance and contain such different collages of plesiomorphic and apomorphic character states that they simply cannot be placed near one another on the cladogram. We suggest under this hypothesis that there was a northern radiation of species into Europe that is quite old and many of the intermediate forms have yet to be discovered or have become extinct. This radiation represented by *vejovskyi-britannica* in the extant fauna has been isolated from its African and Asian ancestors for a long enough period of time to look very different. The *kosztarabi-loebli-guineensis* group is part of a second radiation that currently is most abundant in east Africa, but also occurs in Asia and west Africa. This hypothesis is supported by the tendency of both lineages to be basal, the incongruence of the distribution of *vejovskyi-britannica* under hypothesis 1 and the incongruence of character reduction under hypothesis 2. The third hypothesis alleviates these inconsistencies.

For now, we consider Fig. 19 to be the best estimate of the phylogeny of the group, but if new material is discovered in Europe, northern Africa and Asia, it could significantly enhance our understanding of the evolutionary history of the genus and could strengthen the support for one of the three possible hypotheses.

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**Appendix 1.** Characters and character states with *Orthezia urticae*, *Mixorthezia reymei* and *Nipponorthezia guadalupensis* as outgroups.

1. *Eye stalk*: (0) not fused; (1) partially or completely fused.
2. *Antennae*: (0) 4 or more segments; (1) 3 segments.
3. *Antennal setae*: (0) spinelike; (1) hairlike.
4. *Number of sensory setae on each side of 1st antennal segment*: (0) none; (1) 1; (2) 2 or more.
5. *Antennal setal bases*: (0) unmodified; (1) placed on raised area of derm.
6. *Sensory seta on 1st segment of antenna*: (0) absent; (1) clavate; (2) hairlike.
7. *Number of setae on apical segment of antenna*: (0) less than 20; (1) 20–60; (2) more than 60.
8. *Tibia and tarsus*: (0) not fused; (1) fused.
9. *Flagellate sensory setae near sensory pore on tibia*: (0) without; (1) 1; (2) 2 or more.
10. *Setae on hind femur*: (0) spines; (1) at least partially hair-like.
11. *Claw digitules*: (0) spinelike; (1) hairlike.
12. *Labium*: (0) 2-segmented; basal segment fused to base; (1) 2-segmented, basal segment distinct.
13. *Abdominal spiracles*: (0) more than 4; (1) 4 or fewer.
14. *Pores in spiracular furrows*: (0) without; (1) with.
15. *Rows of spines inside ovisac not counting spines around vulva*: (0) more than 2; (1) 2; (2) 1.
16. *Loculi in multilocular pores*: (0) 4 loculi; (1) more than 4 loculi.
17. *Rows of multilocular pores associated with rows of setae in ovisac band*: (0) absent; (1) one; (2) 2 or more.
18. *Cluster of multilocular pores near anal ring*: (0) absent; (1) present.
19. *Quadrilocular pores*: (0) with obvious loculi; (1) highly modified.
20. *Rows of pores in anal ring*: (0) more than 2; (1) 2.
21. *Dorsal plate*: (0) absent; (1) present.
22. *Thumb-like pores near anal ring*: (0) absent; (1) present.
23. *Clavate setae on abdomen*: (0) absent; (1) present.
24. *Dorsomedial bare area*: (0) absent; (1) narrow; (2) wide.
25. *Triplex setae on labium*: (0) absent; (1) present.
26. *Wax plates 8, 9 and 10*: (0) divided segmentally; (1) segmental divisions fused; (2) absent.
27. *Wax plate 13*: (0) surrounding coxa; (1) triangular in shape; (2) absent.
28. *Wax plate 17 and 18*: (0) surrounding coxa; (1) triangular in shape; (2) absent.
29. *Wax plate 15 and 16*: (0) large; (1) small.
30. *Wax plate 19*: (0) present; (1) absent.
31. *Wax plate 7*: (0) divided segmentally; (1) at least partially fused.
32. *Wax plates 5 and 6*: (0) large; (1) small.
33. *Wax plate 3*: (0) not divided medially; (1) divided medially.
34. *Wax plate 3*: (0) separate from plate 4; (1) fused with plate 4.
35. *Spines between hind legs and ovisac band*: (0) present; (1) absent.
36. *Anterior abdominal spiracles*: (0) dorsal; (1) ventral.
37. *Anal ring*: (0) on dorsal surface; (1) in fold of dorsal derm.

## Appendix 2. Character matrix.

	Character number
	1111111111222222222233333333
	1234567890123456789012345678901234567
<i>Orthesia urticae</i>	0000000000000000000000000000000000
<i>Nipponorthesia guadalcanalia</i>	0110101111000121200000010011110101110
<i>Mixorthesia reynei</i>	100000000001000020001000000000000111
<i>O. ankazobeensis</i>	1111111101011111111111102122001011111
<i>O. benedictyi</i>	102121210101111121111011211001011111
<i>O. britannica</i>	1101111101011121011011021222100111111
<i>O. ethiopiensis</i>	111212111111111121111102122211111111
<i>O. fersii</i>	1102111101011112111111112111091011011
<i>O. glihomeei</i>	110121110101111121111111122001011111
<i>O. guineensis</i>	11012112011111110110011110106010111
<i>O. jermyi</i>	11011211101011111111111102122201101111
<i>O. kosztarabi</i>	11011221201111112100101101100001010011
<i>O. loebli</i>	112111120110101010010110100001010011
<i>O. madecassa</i>	11021111010111111111011011222111001111
<i>O. mahunkai</i>	111212111111111121101111211011011111
<i>O. matileffererae</i>	110121110101111121111102122211111111
<i>O. netliae</i>	1112122111111111211111121222001011111
<i>O. vejvodskiyi</i>	1102111101011121011011021222110100111
<i>O. williamsi</i>	110121110101111111111111221091011111